

ESSAYS AT THE INTERSECTION OF
BEHAVIORAL ECONOMICS AND PUBLIC
POLICY

A Dissertation

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

by

Nichole Elizabeth Szembrot

August 2014

© 2014 Nichole Elizabeth Szembrot

ALL RIGHTS RESERVED

ESSAYS AT THE INTERSECTION OF BEHAVIORAL ECONOMICS AND PUBLIC POLICY

Nichole Elizabeth Szembrot, Ph.D.

Cornell University 2014

In political campaigns, candidates often avoid taking positions on issues, instead making vague statements that conceal the policy preferences that would guide them if elected. The explanation for ambiguity proposed in the first chapter is that voters do not understand the informational content of a non-announcement. If voters are Bayesians, unraveling occurs, with only the most extreme candidates remaining ambiguous. However, if voters under-appreciate the relationship between candidates preferences and their strategies, more moderate candidates may also choose to be vague. The first chapter develops a model of candidate competition in which candidates can choose whether or not to announce their policy preferences to voters and applies Eyster and Rabin's (2005) concept of cursed equilibrium, which allows for varying degrees of understanding of the connection between type and strategy. The second chapter describes and analyzes the results of an experimental test in which subjects in the lab play an election game based on an extension of the model that allows candidates to choose whether or not to make policy commitments. While the majority of subjects make choices that are consistent with the Bayesian model, a substantial fraction shows varying levels of cursedness.

The third chapter (joint work with Dan Benjamin, Ori Heffetz, and Miles Kimball) proposes foundations and a methodology for survey-based tracking of well-being. First, we develop a theory in which utility depends on "fun-

damental aspects" of well-being, measurable with surveys. Second, drawing from psychologists, philosophers, and economists, we compile a comprehensive list of such aspects. Third, we demonstrate our proposed method for estimating the aspects' relative marginal utilities—a necessary input for constructing an individual-level well-being index—by asking 4,600 US survey respondents to state their preference between pairs of aspect bundles. We estimate high relative marginal utilities not only for happiness and life satisfaction, but also for aspects related to family, health, security, values, and freedoms.

BIOGRAPHICAL SKETCH

Nichole Szembrot received a Bachelor of Arts degree from Boston University in 2009, with a joint concentration in economics and mathematics. She was enrolled in a dual-degree program that allowed her to begin graduate coursework in her junior year, culminating in the receipt of the Master of Arts degree in economics in 2009 as well. She entered the Ph.D. program in economics at Cornell University in the fall of 2009.

Her interest in the effects that an unsophisticated electorate have on public policy developed during the 2008 US Presidential election campaign. She collected a wealth of anecdotal evidence regarding voters' decisions while canvassing as a political campaign intern. While working as an intern at the Center for Economic and Policy Research in the summer of 2008, she became aware of the large gap between facts and beliefs commonly held by voters regarding public policy. The first two chapters of this dissertation begin to understand the source of this discrepancy and its consequences for policy outcomes.

ACKNOWLEDGEMENTS

I am very grateful to my advisers Ted O'Donoghue, Steve Coate, and Ori Hefetz for their advice and guidance on this dissertation. I am especially grateful to Ted for his dedication to the education of graduate students, as was evident in his comments on countless drafts and support throughout my time as a graduate student. I also thank Dan Benjamin and Alex Rees-Jones for their helpful comments on drafts of the first two chapters. I would also like to thank participants in the Cornell Behavioral Economics Research Group and Cornell Behavioral/Experimental Economics lab meeting, and seminar/conference audiences at Cornell University, University of Virginia, Trinity College, Western Economic Association International Annual Conference (2013), and Haverford Meeting on Behavioral and Experimental Economics (2013) for their feedback on the first two chapters. I thank the Cornell Economics Department for the financial support that allowed me to conduct the experiment for my second chapter.

My co-authors on the third chapter and I thank Gregory Besharov, Erzo F. P. Luttmer, Ted O'Donoghue, Andrew Oswald, Matthew Rabin, and Alex Rees-Jones for valuable early discussions and suggestions, and Matthew Adler, Aaron Bodoh-Creed, Alexander Cappelen, Viktoria Dalko, Angus Deaton, Koen Decancq, Marc Fleurbaey, Carol Graham, John Ifcher, Vithala Rao, Moses Shayo, and Bertil Tungodden for valuable comments. We thank the editor, Marianne Bertrand, and three anonymous referees for suggestions that substantially improved the paper. For helpful feedback, we are grateful to participants at the Cornell Behavioral Economics Research Group and the Cornell Behavioral/Experimental Lab Meetings, and conference and seminar audiences at the WEAI annual meetings (2011, 2013), AEA annual meetings, IZA Workshop on Sources of Welfare and Well-Being, Michigan Social Psychology-

Economics Workshop, Bay Area Behavioral and Experimental Economics Workshop, Technion's Minerva Workshop on Decisions and Emotional Expressions, Samos AGT Summer School, NBER SI, Well-being in Contemporary Society Conference, Stanford Institute for Theoretical Economics, Paris Workshop on Well-Being and Preferences, New Directions in Welfare Economics III Conference, Aspen Conference on Economic Decisionmaking, Bank of Israel, Cornell, Hebrew University, London School of Economics, Norwegian School of Economics, Paris School of Economics, Tel Aviv University, UCLA, USC, Zurich, a University of Warwick short course on Cognitive Economics, and a Tel Aviv University mini-course on Happiness Measures in Economics. We thank Brice Cooke, Yeon Sik Cho, Thomas Davidson, Julia Goorin, Anthony Hawkins, Allen He, Julian Hsu, Sarina Kumar, Yupeng Li, Allison Nunez, Bora Park, Nathaniel Schorr, Atik Shah, Andrew Simon, Martha Widger, and especially Melissa Bickerman, Jaesun Lee, and Andrew Sung, for their research assistance. For financial support we are grateful to Cornell's Institute for Social Science, Samuel Curtis Johnson Graduate School of Management, and NIH/NIA grants R01-AG040787 to the University of Michigan and T32-AG00186 to the NBER.

TABLE OF CONTENTS

Biographical Sketch	iii
Acknowledgements	iv
Table of Contents	vi
List of Tables	viii
List of Figures	ix
 1 Are Voters Cursed When Politicians Conceal Policy Preferences? Theory	 1
1.1 Introduction	1
1.2 Literature Review	6
1.3 Announcement Game	9
1.3.1 Environment	9
1.3.2 Timing	10
1.3.3 Payoffs	12
1.3.4 Equilibria	13
1.3.5 Welfare	26
1.4 Commitment Game	28
1.5 Conclusion	37
 2 Are Voters Cursed When Politicians Conceal Policy Preferences? Experiment	 39
2.1 Introduction	39
2.2 Literature Review	42
2.3 Experimental Design	44
2.3.1 Election Game	48
2.3.2 Test of ability to use Bayes' Rule	52
2.3.3 Tasks to measure risk aversion	52
2.3.4 Demographic questionnaire	53
2.4 Using model predictions to look for evidence of cursedness	53
2.5 Results	59
2.5.1 Aggregate results	59
2.5.2 Individual behavior	67
2.5.3 Extreme avoidance of candidates who take no position	74
2.5.4 Using belief data	78
2.6 Discussion of avoidance of candidates who took no position	89
2.6.1 Preference for character interpretation	89
2.6.2 Alternative explanations	91
2.7 Conclusion	93
 3 Beyond Happiness and Satisfaction: Toward Well-Being Indices Based on Stated Preference	 95
3.1 Theoretical Framework	102
3.2 Aspects of Well-Being	108
3.3 Survey Design	112
3.3.1 Scenario Screens	112
3.3.2 Instructions and Questionnaire	115
3.3.3 Design versus Theory	116
3.4 Empirical Results: Marginal Utility Estimates	117
3.4.1 Respondent Demographics	119

3.4.2	Personal Choices: Benchmark Specification and Results . .	119
3.4.3	Personal Choices: Discussion	129
3.4.4	Policy Choices	130
3.4.5	Cross-Group Heterogeneity	133
3.5	Robustness and Additional Results	135
3.6	Pragmatics	139
3.6.1	Overlapping Questions	140
3.6.2	Abridged Index	142
3.6.3	Pooling Respondents	144
3.7	Concluding Remarks	146
A	Appendix to Chapter 1	149
A.1	Proofs for Theoretical Results	149
A.1.1	Announcement Game	149
A.1.2	Commitment Game	164
B	Appendix to Chapter 2	186
B.1	Experiment Materials	186
B.2	Belief Incentivization Procedure	234
B.3	Equilibria in Mixed Strategies	235
B.4	Additional Results	249
C	Appendix to Chapter 3	262
C.1	Aspects of Well-Being	262
C.1.1	Classes of Measures of Aspects of Well-Being	262
C.1.2	Aspects of Well-Being: Phrasing	268
C.1.3	Aspects of Well-Being Origin: Legend	269
C.1.4	Our Master List of 136 Aspects:	275
C.1.5	Aspects of Well-Being by Whom They Refer To	282
C.1.6	Aspects 1-108 Modified to Apply to Everyone (<i>everyone-</i> aspects)	284
C.1.7	Aspects 1-108 Modified to Apply to Others (<i>others-</i> aspects)	289
C.2	Instructions Screen	295
C.3	Demographics from the Census	296
C.4	Detecting Overlap in Survey Questions	297
C.4.1	Illustrative Example	299
C.4.2	Theoretical Framework	303
C.4.3	The composite-aspect approach	308
C.4.4	The averaging-interpretation approach	313
C.4.5	Proofs	316
	Bibliography	320

LIST OF TABLES

2.1	Demographics	47
2.2	Election Game Payoffs	49
2.3	Model Predictions	55
2.4	Proportion of Votes That Were For A Candidate Who Took No Position Over A Candidate Who Committed To B/D	61
2.5	Individual Voter Choices Between A Candidate Who Took No Position and A Candidate Who Committed to B/D	68
2.6	Proportion of Votes That Were For A Candidate Who Committed To A/E Over A Candidate Who Took No Position	75
2.7	Proportion of Votes That Were For A Candidate Who Took No Position Over A Candidate Who Committed To B/D: Control For Voting for A/E Over No Position	76
2.8	Expected Value of a Candidate Who Took No Position	84
2.9	Belief Breakdown	85
2.10	Expected Value of a Candidate Who Took No Position: Control for Belief in Commitment Equilibrium	86
2.11	Proportion of Votes That Were For A Candidate Who Took No Position Over A Candidate Who Committed To B/D: Control for Beliefs About Equilibrium	88
3.1	Respondent Demographics	118
3.2	Relative Marginal Utility Estimates	121
B.1	Sample Size	250
B.2	Proportion of Votes That Violated Monotonicity	251
B.3	Proportion of Votes That Were For A Candidate Who Took No Position Over A Candidate Who Committed To B/D: Low Re- sponse Error	252
B.4	Individual Voter Choices Between A Candidate Who Took No Position and A Candidate Who Committed to B/D: 70 Percent Cutoff	253
B.5	Beliefs About The Strategy Chosen By A Candidate Who Prefers A/E	254
B.6	Beliefs About The Strategy Chosen By A Candidate Who Prefers B/D	255
B.7	Beliefs About The Strategy Chosen By A Candidate Who Prefers C 256	256
B.8	Actual Behavior of Subject-Candidates	257
B.9	Beliefs About A Candidate Who Took No Position	258
B.10	Proportion of Votes That Were For A Candidate Who Committed to A/E Over a Candidate Who Took No Position: Low Response Error	260
B.11	Proportion of Votes That Were For A Candidate Who Committed To A/E Over A Candidate Who Took No Position : Control for Last Period	261
C.2	Detailed Citation for the Census Information in Table 3.1	296

LIST OF FIGURES

1.1	Graphical Representation of the Policy Space	3
2.1	Distribution of Coefficient of Absolute Risk Aversion	64
2.2	Distributions of Cursedness Parameter	73
2.3	Mean Beliefs About Subject-Candidates' Strategies	78
2.4	Mean Beliefs About Programmed Candidate Strategies	79
2.5	Mean Beliefs About the Preferred Policy of a Candidate Who Took No Position	82
3.1	Sample Scenario	99
3.2	Partial Welfare Ordering from Non-Local Changes in the Well- Being Index	106
3.3	Relative Marginal Utility Estimates	127
3.4	Relative Marginal Utility Estimates: 108 <i>you</i> - and <i>everyone</i> -aspects	132
C.1	Illustration for Proposition 16	312

CHAPTER 1
ARE VOTERS CURSED WHEN POLITICIANS CONCEAL POLICY
PREFERENCES? THEORY

1.1 Introduction

In political campaigns, candidates often avoid taking positions on issues, instead making vague statements that conceal the policy preferences that would guide them if elected. For example, Tomz and Van Houweling (2009) analyzed statements made regarding tax policy by the presidential and vice-presidential candidates in 40 primary debates (25 Democratic, 15 Republican) and four general election debates during the 2007-08 election cycle. They found that over half of such statements were ambiguous. For example, a candidate might say that he would not increase taxes, but he would not reveal the magnitude of the decrease in taxes that he supported. Given such a statement, voters would be left unsure whether the candidate would enact extreme tax cuts, moderate tax cuts, or leave tax rates as they were. The existence of such ambiguity is a fundamental puzzle in political economy. Since a representative democracy relies on having elections to choose officials who will make important decisions, it is crucial that the electorate be able to select a candidate who represents its interests. When voters must choose candidates without knowing their policy intentions, it seems likely that elections will not be able to serve this function. An understanding of why politicians choose to be ambiguous will help society to form policies that will make it more likely that elections serve the public interest.

This chapter proposes a novel explanation for ambiguity in elections: voters do not fully understand the informational content of a non-announcement. If voters were fully rational, they would be able to infer that the fact that a candidate chooses to conceal his preferences actually reveals information about those preferences: they must not be congruent with the voters' preferences. However, if voters do not follow this reasoning, then candidates may actually be able to conceal their preferences by making vague campaign statements.

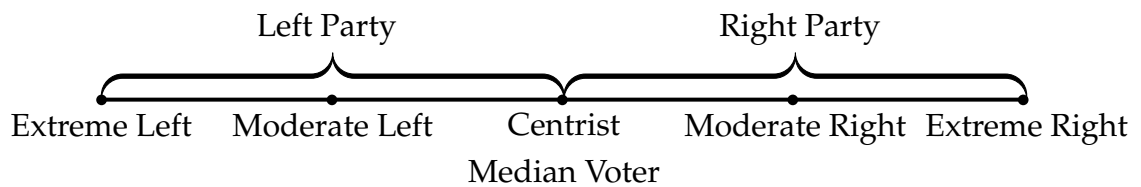
As in many economic contexts, information asymmetries abound in political environments. As such, the tools and insights from analysis of games of incomplete information played in economic environments also apply to many problems in politics. This chapter focuses on a particular asymmetry: politicians have more information about their own policy preferences than their opponents and the electorate have. The key feature of signaling games is the opportunity for a player whose type is unknown by other players to choose an action that will be observed by other participants. If the payoffs associated with taking various actions differ by type, then a player's decision to choose one action over others may reveal information about his type to the other players.

In Akerlof's (1970) classic example of the used car market, a seller knows the quality of his car, but potential buyers do not. There, the unknown type is the quality of the car. An owner of a low-quality car will have a low valuation and be willing to accept a low price, while an owner of a high-quality car will prefer to keep the car for himself rather than selling for a low price. Therefore, buyers can make inferences about the value of the car after observing an action taken by the seller: his willingness to sell the car at a given price.

Analogously, in the environment studied in this chapter, the type of a candidate is the policy that he would like to implement, known only to himself. During the campaign, candidates may choose to announce their preferred policies to voters. Since a candidate's willingness to reveal his true policy position depends on the likelihood that announcing it will garner support from the electorate, a candidate's decision to conceal his preferred policy may actually reveal information about that policy to voters. More concretely, consider the following example, in which citizens must elect a representative who will make a decision regarding gun control policy. Suppose that the median voter prefers a centrist gun control policy: mandatory registration and background checks. There are two political parties, each composed of three equally sized factions. Candidates from the Left party generally prefer a higher level of gun control. The Left party includes centrists, moderate Leftists who prefer somewhat more stringent regulations (banning military-style assault rifles), and extreme Leftists

who would ban private ownership of handguns. Within the Right party, there are centrists, moderate Rightists who would allow some exemptions from background checks, and extreme Rightists who would not require gun registration. Suppose that the median voter is equally dissatisfied with moving to the left or to the right of her ideal policy. Figure 1.1 illustrates this environment graphically.

Figure 1.1: Graphical Representation of the Policy Space



Returning to the familiar used car example, Akerlof argues that if buyers are naively willing to pay the expected value of a car, owners of high-value cars will not be willing to accept this price. Buyers then infer that only below-average cars are in the market, and they would be willing to pay the expected value of a below-average car if this were the case. However, given this buyer behavior, only cars of very low value, below the expected value of below-average cars, would be in the market. The result of iterating through this logic is that the used car market will not exist, because buyers would infer from a seller's willingness to participate that the car up for sale is a lemon.

Similar logic applies in the election example. A centrist candidate will not want to pool with less desirable candidates and will clearly choose to announce his preferred policy. Suppose first that only centrist candidates make announcements. If voters update correctly, they would infer that a Left politician who made no announcement either wants to ban assault rifles or also wants to ban handguns. Therefore, a moderate-Left politician would be more appealing to voters if he revealed his preferred policy than if he pooled with extremists by taking no position. Thus, only the extreme candidates could possibly remain

silent; regardless of whether they announce their true preferences or try to conceal them, voters would infer that they are "lemons."

The standard model of play in games of incomplete information assumes that players are able to go through the train of logic outlined above and update their beliefs about other players' types correctly. However, the unraveling process may break down if voters lack sufficient cognitive ability or are simply unwilling to pay the effort costs that may be required to think through a complex game. If when a candidate takes no position, voters (mistakenly) put enough weight on the candidate being a centrist, they would instead prefer the candidate who took no position to a candidate who revealed himself to be moderate-Left or moderate-Right. If candidates anticipate this voting behavior, then moderate Left and Right candidates may also choose to remain vague rather than making a policy announcement. In this way, ambiguity in politics may be a response by candidates to voters who are affected by this behavioral bias when forming beliefs about candidates.

This chapter develops a game-theoretic model that formalizes the ideas described above. In the model, an election is held to select a candidate who will implement one of five possible policies. Each player receives a payoff that depends only on how close the policy implemented is to his preferred policy. The median voter prefers the centrist policy. There are two candidates, one from either side of the political spectrum. Each candidate prefers either the centrist policy, a policy that is moderate within his party (henceforth, simply moderate), or an extreme policy; the candidates' preferred policies are private information.

In the baseline analysis, it is assumed that each candidate chooses to announce his preferred policy or to take no position. Intuitively, this reflects that politicians cannot credibly promise to implement policies that they do not support. This case will be referred to as the announcement game.

The model is solved using Eyster and Rabin's (2005) concept of cursed equilibrium. When a voter is "cursed," she under-appreciates the relationship between a candidate's type (his policy preference) and his campaign strategy. Her

posterior beliefs about the types of the candidates following the campaign stage are a convex combination of her prior beliefs and the true Bayesian posterior beliefs. This modeling assumption captures the idea that a person may accurately predict the distribution of actions taken but have incorrect posterior beliefs about a player's type given the action taken by that player. The cursed equilibrium model allows for varying degrees of strategic sophistication, and it has two special cases. If voters are not cursed (believe that candidates always play their type-specific strategies), this concept is simply Bayes-Nash equilibrium. This generates the unraveling logic described above, which leads only the most extreme candidates to have an incentive to take no position. On the other hand, if voters are fully cursed, they do not update their beliefs at all based on actions taken by other players. In this case, when a voter sees that a candidate does not make a policy announcement, her belief that the candidate has a given policy preference is simply her prior belief that the candidate has that policy preference, based on the distribution of candidate preferences. The model also allows individuals to be partially cursed, which means that they are not completely naive but still do not fully understand the relationship between preferences and strategies.

Mistaken beliefs about the likely preferred policy of a candidate who took no position could lead voters to choose a candidate who concealed his policy preference over a candidate who revealed himself to be a moderate-Left or moderate-Right candidate. This chapter will show that if voters are sufficiently cursed, then moderate candidates would respond by remaining ambiguous about their future plans.

A second game is also considered, to check which intuitions from the announcement game continue to hold when candidates have additional strategies available to them. In what will be referred to as the commitment game, candidates are not required to implement their preferred policies. During the campaign stage, candidates choose to either commit to any policy or take no position. The winning candidate must honor his commitment if he made one during the campaign, but a candidate who takes no position can implement his

preferred policy. Candidates thus face a trade-off between increasing the probability of winning the election by choosing a policy that the voter prefers and being able to implement a policy that he prefers conditional on winning.

The rest of the chapter is organized as follows. Section 1.2 provides a brief literature review. Section 1.3 analyzes a model in which candidates decide whether or not to announce their preferred policies to voters before the election. Section 1.4 extends the model to allow candidates to commit to any policy. Section 1.5 concludes.

1.2 Literature Review

This chapter contributes to the theoretical literature in economics and political science that attempts to explain the prevalence of ambiguity in campaigns.

One class of explanations views ambiguous statements by candidates as responses to true voter preferences. Shepsle (1972) makes an important theoretical contribution with an extension of the Downsian model in which candidate strategies are probability distributions, instead of points on a subset of the real line. He shows that, when voters care intensely about getting their most preferred option and experience diminishing sensitivity further away from their bliss points, a challenger can defeat an incumbent whose position is known by choosing a non-degenerate lottery, rather than committing to a single point in the policy space. On the other hand, if voters are risk-averse, a candidate should not take actions that would make voters uncertain about his policy position (Bernhardt and Ingberman 1985). Aragonès and Postlewaite (2002) reinforce Shepsle's results in a model similar to his, except for the introduction of asymmetry by requiring each candidate to put some minimum probability on that candidate's "preferred" policy. These authors are also responsible for the framing of the key assumption as preference intensity, rather than risk-loving preferences. Preference intensity will also play a role in the model developed in this chapter; all else equal, a voter would have a stronger preference for a

candidate whose policy preference is uncertain compared to a certain moderate if the voter cares a great deal about obtaining her favorite alternative and is less sensitive to changing from a moderate to an extreme position. This chapter builds on the theoretical contributions made in these papers.

Several authors have noted that ambiguity on a given policy issue may be beneficial for candidates when voters' preferences are multi-dimensional. According to Page's (1976) emphasis theory, candidates choose how much time to devote to informing voters about their positions on each issue; ambiguity is the result of spending little time on an issue. He shows in an example that candidates optimally choose to focus voters' attention on issues on which there is consensus, leaving no attention to divisive issues. Dellas and Koubi (1994) suggest that candidates hide information about their performance from voters in order to win elections based on charisma and similar characteristics. While this chapter considers political competition on a single dimension, future work could consider the interaction of the mechanism analyzed here and the additional concerns that arise with competition on several dimensions.

Other models are motivated by the need for politicians to appeal to different types of voters simultaneously. If candidates must simultaneously appeal to moderate voters and extremist campaign contributors, as assumed in Alesina and Holden (2008), candidates with different policy preferences may pool by committing to enact a policy within an interval that contains both of their true preferences. However, this result hinges on the assumption of a specific distribution of voter preferences, such that movement along the policy spectrum changes the probability of winning the election non-monotonically. Relatedly, candidates may face initial uncertainty regarding the location of the median voter (Alesina and Cukierman 1990; Meirowitz 2005; Agranov 2012); voters are *ex ante* identical, but they differ in their policy preferences *ex post*. In these models, policy-motivated candidates do not reveal information about their preferences when taking no position, because non-extreme candidates also have a desire to remain ambiguous when the preference of the median voter is not known with certainty. Without this assumption, introducing policy-motivated

candidates would add a layer of complexity, since actions taken during campaigns (and in office, in dynamic models) may reveal information about what a candidate will do in the future. Given the present ubiquity of polls in the time leading up to elections, explanations that rely on having enough of this uncertainty may not seem as plausible as they did even a few years ago. The model presented below drops the assumption of uncertainty about the location of the median voter, implying that the only motive for keeping quiet about one's policy position is to conceal a preference for an unpopular policy.

Somewhat similarly, ambiguity may be a response to uncertainty about the optimal policy that will not be resolved until after the election. Aragonès and Neeman (2000) posit that ambiguity exists in elections because candidates care directly about being ambiguous, because they would like to have the flexibility to adjust policy if necessary. In their model, there exists a trade-off between giving the median voter what she wants in order to get elected and remaining ambiguous to have the flexibility once in office. This mechanism may be at work in reality; this channel is shut down in the model described in this chapter, because there is no shock to policy preferences after the election takes place.

This chapter is not the first work to point out that voters should make inferences about the types of candidates who would choose to be vague; Chappell (1994) also makes that argument. However, his model differs from this chapter's model in several important assumptions, and his results are not directly comparable to those that will be discussed here. Two papers are most closely related to this chapter in the sense that candidates are responding to behaviorally biased voters. Callander and Wilson (2008) develop a model of context-dependent voting, in which voters care about each candidate's platform directly and in comparison to his opponent's platform. Given this, and assuming that there is uncertainty about the valence (dis)advantage held by each candidate, each candidate chooses a probabilistic platform that put some weight on the median voter's position and some weight on a position closer to his own. In Jensen's (2009) model, voters interpret vague statements made by candidates that they like for non-policy reasons by projecting their own views onto such

candidates. His key result is that a well-liked office-motivated candidate can defeat a candidate who commits to the median voter's position by taking an interval position around the median. Voters to the left of the median believe that the ambiguous candidate is to the left (and thus prefer him to the median voter's position), while voters to the right of the median believe that he is to the right (and thus *also* prefer him to the median voter's position). It is not clear how this bias would interact with cursedness, because Jensen does not analyze the bias within a signaling game with policy-motivated candidates.

This chapter proposes a new explanation for why policy-motivated candidates are sometimes able to get away with not making policy announcements during campaigns. Ambiguity has a benefit for policy-motivated candidates who do not agree with the median voter, because it gives them the opportunity to implement their preferred policies without having to run on them. The contribution of this chapter is to identify a novel mechanism that has not been discussed in the existing literature. It provides a view of political competition as a signaling game played by actors with less than complete cognizance of that strategic environment. Future work should do more to connect these disparate explanations, but an understanding of this key mechanism is a prerequisite for such work.

1.3 Announcement Game

1.3.1 Environment

The purpose of the election is to select a candidate who will implement one of five possible policies. There are two policy-motivated candidates¹, one from each side of the ideological spectrum. The reader may think of them as being

¹

The assumption that candidates are policy-motivated, rather than purely office-motivated, has become fairly standard since models using that assumption were studied by Wittman (1983) and Calvert (1985).

randomly chosen (or chosen based on characteristics that are orthogonal to policy preference) from two entrenched political parties. Candidate 1 may prefer policy A, B, or C, and Candidate 2 may prefer policy C, D, or E. There are N voters distributed across the policy space, and the median voter prefers policy C.²

The overall distribution of candidate preferences is symmetric, and this distribution is common knowledge. Let π_j^i be the probability that Candidate i 's preferred policy is j . Since the distribution is symmetric, the notation can be simplified by writing $\pi_A = \pi_A^1 = \pi_E^2$, $\pi_B = \pi_B^1 = \pi_D^2$, and $\pi_C = \pi_C^1 = \pi_C^2$. Each player receives utility based on how close the implemented policy is to his preferred policy; payoffs are described in more detail below. Candidates are purely policy-motivated and receive no additional reward from holding office.

In this game, all candidates will implement their preferred policies. The decision for a candidate in the campaign stage is whether or not to reveal this preferred policy to voters.

1.3.2 Timing

The timing of the announcement game is as follows:

Stage 0: Nature draws a preferred policy for each candidate, and each candidate learns his own preferred policy.

Stage 1: The candidates simultaneously choose campaign strategies. Each candidate chooses whether to reveal or conceal his preferred policy.

²

The median voter theorem (Black, 1958) implies that, since majority rule is assumed and preferences are single-peaked, the outcome of the election will be determined by the preference of the median voter; hence, analysis is greatly simplified by focusing on the preference of the median voter. Additionally, assuming that the median voter prefers C is consistent with work done by Anderson and Meagher (2012), who show that, with endogenous party formation in a continuous environment, the parties' moderate boundaries lie on either side of the median voter.

Stage 2: Nature determines whether voters will observe³ each candidate's policy preference announcement. With probability $\gamma \in (0, 1)$, any announcement made by a candidate will be seen by voters; with probability $1 - \gamma$, voters will see that the candidate took no position, regardless of the strategy he chose. Realizations are independent across candidates. All players in the game understand that strategies chosen by candidates are translated with some noise into platforms observed by voters in this way. To clarify the difference between what the candidates choose and what the voters observe, the actions chosen by the candidates will be referred to as *strategies*, and the campaign messages viewed by the voters after Nature has moved will be referred to as *platforms*.

Stage 3: Voters observe the campaign platforms and choose their preferred candidates. If a voter is indifferent, she abstains.⁴ The candidate with the most votes wins the election and implements his preferred policy. If both candidates receive the same number of votes, a winner is chosen at random, with each candidate having an equal chance of being chosen.

Stage 2 exists for technical reasons; allowing the no position platform to occur with positive probability regardless of the strategies chosen implies that the Bayes-Nash equilibrium concept can be used without the need for refinements. Suppose to the contrary that a candidate has perfect control over whether or not his preferred policy is revealed to voters. If all candidates choose to reveal their positions in equilibrium, then Bayes' Rule does not prescribe beliefs if a voter observes the off-path action of taking no position. This paper deals with this technical issue by introducing a source of uncertainty and taking limits as γ approaches one (voters always observe the chosen strategies).

³

The theory is written as if there is some probability that a message sent by a candidate is not received by the voters. Alternatively, one can interpret this as a probability that a candidate is unable to convincingly convey his policy preference to the voters.

⁴

Nothing changes if she votes randomly when indifferent instead.

1.3.3 Payoffs

Each player chooses his strategy to maximize his expected utility. Suppose that, as illustrated in the introduction, each policy can be represented by a point on the real line, with one unit of distance between each pair of adjacent policies. Each player i receives utility payoffs that depend on his preferred policy, denoted by x_i , and the policy implemented, \bar{x} . Let z_i denote the distance between player i 's preferred policy and the policy implemented: $z_i = |x_i - \bar{x}|$. Each player's preferences are represented by $u(z) = -f(z) + \varphi$, where $f(z)$ is increasing in z . This assumption implies that u is decreasing in the distance between the preferred policy and the policy implemented. φ is a constant set such that $u(4) = 0$. This normalizes the utility function, assigning the value 0 to the greatest distance between policies possible in this environment.

If $f(\cdot)$ is a convex function, as is commonly assumed in the literature, then players are risk-averse with respect to policies. For example, the median voter (who prefers C) would prefer to implement B/D for sure to a lottery that gives equal probability to C, B/D, and A/E (an expected distance of 1). In contrast, if $f(\cdot)$ is concave, then the opposite is true. In this case, players care intensely about receiving their preferred policies and are less sensitive to differences between policies further away from the preferred policy.

The utility function was defined above in a way that facilitates these comparisons between other this and other papers. However, for ease of notation, define the following values: for $i = 1, \dots, 5$, $u_i = u(i - 1)$. It may also be easier for the reader to remember that the index one corresponds to the best possible situation, in which the preferred policy is equal to the policy implemented. u_2 is the utility received from the second-best policy, and so on.

1.3.4 Equilibria

Let θ_1 and θ_2 denote the types of Candidate 1 and Candidate 2, respectively. A strategy for Candidate 1, $\sigma_1(\theta_1)$, is a mapping from preferred policy $\theta_1 \in \{A, B, C\}$ to campaign action $a_1 \in \{\theta_1, \emptyset\}$; he chooses whether to announce his preferred policy or to announce nothing. The strategy for Candidate 2, $\sigma_2(\theta_2)$, is defined analogously. Let z_1 and z_2 denote the platforms of Candidate 1 and Candidate 2, respectively. Recall that due to Nature's move in Stage 2, $z_j = a_j$ with probability γ and $z_j = \emptyset$ with probability $1 - \gamma$. A strategy for voter i , $\sigma_{vi}(z_1, z_2 | \chi_i)$, is a mapping from observed candidate platforms z_1 and z_2 to a voting action $a_{vi} \in \{1, 2, 0\}$. She chooses whether to vote for Candidate 1, vote for Candidate 2, or abstain (denoted by 0) after viewing the platforms. Her strategy may depend on her cursedness parameter χ_i , which will be defined below.

The following definition applies the standard Bayes-Nash equilibrium solution concept to this game.

Definition 1. *The Bayes-Nash equilibrium of the announcement game is a strategy profile σ^{BN} and set of beliefs $\pi_{\theta|a}$ for voters such that*

1. *For each candidate j , $\sigma_j^{BN}(\theta_j)$ maximizes his utility, given $\sigma_{-j}^{BN}(\theta_{-j})$ and $\sigma_{v1}^{BN}(z_1, z_2), \dots, \sigma_{vN}^{BN}(z_1, z_2)$.*
2. *For each voter i , $\sigma_{vi}^{BN}(z_1, z_2)$ maximizes her utility, given $\sigma_1^{BN}(\theta_1)$, $\sigma_2^{BN}(\theta_2)$, and her beliefs $\pi_{\theta|a}$.*
3. *Each voter forms posterior beliefs $\pi_{\theta|a}$ using Bayes' Rule.*

In the definition of the Bayes-Nash equilibrium, the notation in the voters' strategies that allows the strategies to depend on χ is suppressed because it is not relevant for this solution concept. Given that all voters form beliefs in the same way and have identical preferences over policies, all voters have the same equilibrium strategies in the Bayes-Nash equilibrium.

When a voter observes that a candidate takes no position, she must form beliefs about the candidate's preferred policy, since that is the policy that he would

implement if elected. Due to Nature's move at Stage 2, there is always positive probability that a candidate's platform will be "no position". In addition, voters' beliefs about the preferred policy of a candidate who makes an announcement are determined by that announcement, since candidates can only make truthful statements. A voter who did not expect a candidate to announce that he prefers A/E nonetheless believes the statement if she does hear it. Therefore, beliefs when platforms that are off the equilibrium path are observed are irrelevant when considering the existence of equilibria.

In a Bayes-Nash equilibrium, all players use Bayes' Rule to update their beliefs about the likelihood that a candidate has each preferred policy conditional on having taken no position. Alternatively, the game can be solved using Eyster and Rabin's (2005) solution concept of cursed equilibrium. This concept is Bayes-Nash equilibrium, with a modification of the requirement that all players use Bayes' Rule when updating their beliefs.

Definition 2. *The cursed equilibrium of the announcement game is a strategy profile σ^* and set of beliefs $\tilde{\pi}_{\theta|a}$ for voters such that*

1. *For each candidate j , $\sigma_j^*(\theta_j)$ maximizes his utility, given $\sigma_{-j}^*(\theta_{-j})$ and $\sigma_{v1}^*(z_1, z_2|\chi_1), \dots, \sigma_{vN}^*(z_1, z_2|\chi_N)$.*
2. *For each voter i , $\sigma_{vi}^*(z_1, z_2|\chi_i)$ maximizes her utility, given $\sigma_1^*(\theta_1)$, $\sigma_2^*(\theta_2)$, and her beliefs $\tilde{\pi}_{\theta|a}$.*
3. *Each voter i forms posterior beliefs $\tilde{\pi}_{\theta|a} = (1 - \chi_i)\pi_{\theta|a} + \chi_i\pi$, where $\pi_{\theta|a}$ is constructed using Bayes' Rule.*

Cursed equilibrium is very much an as-if model. Beliefs are modeled as a linear combination that puts weight $1 - \chi$ on the correct Bayesian posteriors and weight χ on the prior beliefs. $\chi \in [0, 1]$ parameterizes the voter's degree of cursedness; a voter who is more cursed has less understanding of the link between type (preferred policy) and strategy chosen. If $\chi = 0$, the voter understands that other players use type-contingent strategies, and the concept reduces to standard Bayes-Nash equilibrium. If $\chi = 1$, the voter is referred to

as fully cursed, and she does not perceive a difference between the strategies chosen by different types. A voter with $\chi \in (0, 1)$ is called partially cursed; she updates from her priors toward the correct Bayesian posterior, but does not fully incorporate the fact that different types may choose different strategies.

χ is allowed to vary across voters. Assuming that there is no correlation between policy preference and cursedness, for large N , the distribution of cursedness conditional on policy preference will be the same as the unconditional distribution of cursedness. One can then think of the median voter in this environment as the voter who prefers C and is more cursed than one half of the voters and less cursed than the other half of the voters. Let χ_m denote this median voter's degree of cursedness. Voters with $\chi < \chi_m$ will have a less positive view of a candidate who takes no position than the median voter, and voters with $\chi > \chi_m$ will like a candidate who takes no position more than the median voter does. Since voter preferences are single-peaked with respect to χ ⁵, the median voter theorem applies, and a candidate who wins the vote of a voter with χ_m will also win the election. For ease of notation, the m subscripts will be dropped, but the degree of cursedness referred to in what follows is χ_m .

Candidates are assumed to be Bayesians, though this is without loss of generality in the announcement game. Since a cursed candidate would correctly predict the average distribution of votes (while making mistakes regarding the choices of individual voters), he does correctly anticipate the behavior of the median voter. As will be shown below, candidates play weakly dominant strategies in equilibrium; therefore, beliefs about the behavior of the opponent, which would be distorted by cursedness, do not affect candidates' behavior.

Unless stated otherwise, all results regarding equilibria refer to cursed equi-

5

Single-peakedness then follows from the definition of cursedness. Cursedness will only affect the perceived expected utility from a candidate who took no position, and that expected utility is simply a linear combination of the expected utility calculated using the correct Bayesian posteriors beliefs and that calculated using the prior beliefs. Therefore, utility from voting for a candidate who takes no position must either strictly increase in χ , strictly decrease in χ or be constant with respect to χ . If it does not depend on χ , then assumptions about the distribution of χ in the population are irrelevant.

libria; however, since Bayes-Nash equilibrium is a special case of cursed equilibrium with $\chi = 0$, these results also apply to Bayes-Nash equilibrium. Attention is restricted to equilibria in which players do not choose weakly dominated strategies. This rules out the possibility that a voter would be indifferent between the candidates because she believes that her vote will not be pivotal. Under this assumption, one can model a voter's decision problem as if she alone determines the outcome of the election. Since there are only two candidates and there is no cost of voting, voting for her favorite candidate based on the policy she expects him to implement if elected weakly dominates all other voting strategies.

Voters' decisions are straightforward given most combinations of candidate platforms. If candidates reveal that they prefer policies that would give the voters the same payoff, then voters would be indifferent between the two candidates and would abstain. If both candidates reveal preferences, but Candidate 1's preferred policy gives the voters a higher payoff than Candidate 2's preferred policy, then the voters would vote for Candidate 1. Voters would also vote for a candidate who revealed that he prefers C over a candidate who took no position, and would vote for a candidate who took no position over a candidate who revealed that he prefers A/E. For voters, the interesting choice is between a candidate who announced a preference for B/D and a candidate who took no position.

The choice of a candidate who has the same preferred policy as the voters is simple, and candidates who prefer C reveal that preference in all possible equilibria. Additionally, it is straightforward to show that candidates who prefer A/E do not reveal their preferred policies in equilibrium. A voter prefers a lottery over implementing A/E, B/D, and C to a candidate who has revealed A/E. Therefore, taking no position is a weakly dominant strategy for candidates that prefer A/E, because it does strictly better when the opponent reveals A/E and is at least as good as revealing A/E against all other strategies. Therefore, equilibria differ only in the strategies chosen by candidates who prefer B/D.

Because there is some probability that Nature will prevent a candidate from credibly announcing his preferred policy, there will be uncertainty about the preferred policy of a candidate who takes no position. However, it may be possible that almost all information about candidate types is revealed. If only one type of candidate chooses to take no position and γ is close to one, then the probability that a candidate who has taken no position is of that type is very high. The label attached to the equilibrium defined just below derives from this fact.

Definition 3. *Near-revelation equilibrium: Candidates who prefer A/E take no position, and all other types reveal their preferred policies. The median voter chooses a candidate who reveals B/D over a candidate who takes no position.*

To understand the decision problem faced by candidates who prefer B/D, one must begin by understanding the voter behavior to which the candidates are responding. Voters' choices depend on their beliefs about the likely preferred policy of a candidate who takes no position. The following lemmas describe the beliefs held by Bayesian and cursed voters, respectively, under the assumption that only candidates that prefer A/E choose to take no position. Proofs of these and all other results are relegated to the Appendix. Additionally, the equations that characterize equilibria more generally, not only in the limit case, can also be found in the Appendix.

Lemma 1. *Suppose that in equilibrium, only candidates who prefer A/E choose to take no position. Then,*

1. *A Bayesian voter believes the following about a candidate who takes no position:*

$$\begin{aligned}\pi_{A|\emptyset} &= \frac{\pi_A}{1 - \gamma(1 - \pi_A)} \\ \pi_{B|\emptyset} &= \frac{(1 - \gamma)\pi_B}{1 - \gamma(1 - \pi_A)} \\ \pi_{C|\emptyset} &= \frac{(1 - \gamma)\pi_C}{1 - \gamma(1 - \pi_A)}\end{aligned}$$

In the limit as $\gamma \rightarrow 1$:

$$\pi_{A|\emptyset} = 1$$

$$\pi_{B|\emptyset} = 0$$

$$\pi_{C|\emptyset} = 0$$

2. A cursed voter believes the following about a candidate who takes no position:

$$\tilde{\pi}_{A|\emptyset} = \frac{\pi_A [1 - \chi\gamma(1 - \pi_A)]}{1 - \gamma(1 - \pi_A)}$$

$$\tilde{\pi}_{B|\emptyset} = \frac{\pi_B [1 - \gamma(1 - \chi\pi_A)]}{1 - \gamma(1 - \pi_A)}$$

$$\tilde{\pi}_{C|\emptyset} = \frac{\pi_C [1 - \gamma(1 - \chi\pi_A)]}{1 - \gamma(1 - \pi_A)}$$

In the limit as $\gamma \rightarrow 1$:

$$\tilde{\pi}_{A|\emptyset} = 1 - \chi(1 - \pi_A)$$

$$\tilde{\pi}_{B|\emptyset} = \chi\pi_B$$

$$\tilde{\pi}_{C|\emptyset} = \chi\pi_C$$

Because there is some chance that a candidate whose platform is "no position" did not choose "no position" as a strategy, uncertainty about the preferred policy of a candidate who took no position remains. The effect on beliefs of adding this uncertainty does not require cursedness as a mediator. However, as the chance of Nature preventing a candidate from revealing goes to zero (as γ approaches 1), the beliefs of a Bayesian voter converge to putting full probability on that candidate preferring A/E. In contrast, a cursed voter may believe that a candidate who takes no position prefers B/D or C even when $\gamma = 1$. The following proposition uses Lemma 1 to show that, when facing Bayesian voters, candidates that prefer B/D are better off revealing their preferred policies than concealing them.

Proposition 1. *In the limit as $\gamma \rightarrow 1$, the near-revelation equilibrium exists as a Bayes-Nash equilibrium.*

Since only candidates who prefer A/E choose to take no position in equilibrium, a Bayesian would know that, in the limit as $\gamma \rightarrow 1$, a candidate who took no position must be a candidate who prefers A/E. Given the voters' behavior, the best response of a candidate who prefers B/D is to reveal his preferred policy, since he would be more likely to win the election by doing so than by taking no position.

In order for the near-revelation equilibrium to exist, even with Bayesian voters, it must be the case that voters would vote for a candidate who revealed himself to prefer B/D over a candidate who took no position. As γ approaches one, the equilibrium will exist regardless of the other parameter values. However, given the uncertainty about the preferred policy of a candidate who took no position caused by γ , it is otherwise necessary to ensure that voters do not prefer a candidate who took no position. If the distribution of preferences were skewed toward centrists and voters' preferences were sufficiently convex over policies, then voters would prefer a candidate who took no position, even if only candidates who prefer A/E actually choose to do so. Introducing γ alone thus can potentially break down the unraveling argument.

The next proposition analogously considers the existence of the near-revelation equilibrium when voters are cursed.

Proposition 2. *As $\gamma \rightarrow 1$, the near-revelation equilibrium exists as a cursed equilibrium if and only if*

$$\chi \leq \chi_{NR} \equiv \frac{u_2 - u_3}{(1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2)} \quad (1.1)$$

Given the distribution of candidate preferences and the median voter's preferences over outcomes, there exists a threshold degree of cursedness; if the median voter is sufficiently close to Bayesian, then the near-revelation equilibrium

exists. In Proposition 5 below, it will be shown that $\chi_{NR} \in (0, 1)$ if $\frac{\pi_A}{\pi_C} < \frac{u_1 - u_2}{u_2 - u_3}$. In this case, if the median voter is sufficiently cursed, then the near-revelation equilibrium does not exist for all parameter values. This is true even as the probability that a candidate will be prevented from revealing his preferred policy goes to zero; cursedness alone can prevent the existence of the near-revelation equilibrium.

Cursed voters do not understand how unlikely it is that a candidate who took no position would implement the voters' preferred policy, since their beliefs are formed as if other types of candidates also sometimes may choose to take no position. If this mistake leads the updated beliefs to not move too far away from the priors, then these voters would prefer a candidate who took no position to one who revealed B/D; in this case, candidates who prefer B/D would choose to deviate from their equilibrium strategies of revealing their preferred policies.

However, if $\frac{\pi_A}{\pi_C} \geq \frac{u_1 - u_2}{u_2 - u_3}$, then $\chi_{NR} \geq 1$, and the near-revelation equilibrium exists, regardless of the degree of cursedness. This condition holds if and only if the median voter prefers receiving u_2 for certain to a random draw from the distribution of candidate preferences. The cursed equilibrium model implies that the most optimistic belief that a voter may hold about a candidate who takes no position is that he is a random draw—rather than disproportionately likely to be an extremist. If the median voter still prefers a candidate who would implement policy B/D, even if fully cursed, then cursedness has no effect on the predictions of the model; the near-revelation equilibrium exists.

Alternatively, candidates who prefer B/D may choose to take no position by making ambiguous campaign statements.

Definition 4. *Ambiguity equilibrium: Candidates who prefer A/E or B/D take no position, and candidates who prefer C reveal their preferred policies. The median voter prefers a candidate who takes no position to a candidate who reveals B/D.*

The following lemma gives the posterior beliefs that voters hold, given that candidates who prefer both A/E and B/D choose to take no position.

Lemma 2. *Suppose that in equilibrium, only candidates who prefer C reveal their preferred policies. Then,*

1. *A Bayesian voter believes the following about a candidate who takes no position:*

$$\begin{aligned}\pi_{A|\emptyset} &= \frac{\pi_A}{1 - \gamma\pi_C} \\ \pi_{B|\emptyset} &= \frac{\pi_B}{1 - \gamma\pi_C} \\ \pi_{C|\emptyset} &= \frac{(1 - \gamma)\pi_C}{1 - \gamma\pi_C}\end{aligned}$$

In the limit as $\gamma \rightarrow 1$:

$$\begin{aligned}\pi_{A|\emptyset} &= \frac{\pi_A}{1 - \pi_C} \\ \pi_{B|\emptyset} &= \frac{\pi_B}{1 - \pi_C} \\ \pi_{C|\emptyset} &= 0\end{aligned}$$

2. *A cursed voter believes the following about a candidate who takes no position:*

$$\begin{aligned}\tilde{\pi}_{A|\emptyset} &= \frac{\pi_A [1 - \chi\gamma\pi_C]}{1 - \gamma\pi_C} \\ \tilde{\pi}_{B|\emptyset} &= \frac{\pi_B [1 - \chi\gamma\pi_C]}{1 - \gamma\pi_C} \\ \tilde{\pi}_{C|\emptyset} &= \frac{\pi_C [1 - \gamma + \chi\gamma(1 - \pi_C)]}{1 - \gamma\pi_C}\end{aligned}$$

In the limit as $\gamma \rightarrow 1$:

$$\begin{aligned}\tilde{\pi}_{A|\emptyset} &= \frac{\pi_A [1 - \chi\pi_C]}{1 - \pi_C} \\ \tilde{\pi}_{B|\emptyset} &= \frac{\pi_B [1 - \chi\pi_C]}{1 - \pi_C} \\ \tilde{\pi}_{C|\emptyset} &= \frac{\pi_C \chi (1 - \pi_C)}{1 - \pi_C}\end{aligned}$$

In this case, there will be uncertainty about the preferred policy of a candi-

date who takes no position, even if $\gamma = 1$, because more than one type chooses that strategy in equilibrium. However, if $\gamma = 1$, a Bayesian would know for certain that a candidate who takes no position cannot prefer policy C. On the other hand, as before, cursed voters perceive more uncertainty than actually exists because they put some probability on a candidate who prefers C choosing to take no position.

The next proposition establishes that choosing to remain ambiguous cannot benefit candidates that prefer B/D when voters are Bayesians.

Proposition 3. *In the limit as $\gamma \rightarrow 1$, the ambiguity equilibrium does not exist as a Bayes-Nash equilibrium.*

First, note that this result does not necessarily hold outside of the limit case. If a Bayesian believed that only candidates who prefer C would choose to reveal their preferred policies, she would know that a candidate who took no position was very likely to prefer B/D or A/E. However, if the probability that a candidate will be prevented from making an announcement is high (γ is low), then a candidate who took no position is only somewhat more likely to prefer B/D or A/E instead of C. Moreover, if in addition voters receive a large utility loss from moving from policy C to B/D and a sufficiently small loss from moving from B/D to A/E, then Bayesian voters would be willing to take on the risk of voting for the candidate who took no position. If voters behaved this way, then candidates who prefer B/D would maximize their winning probabilities by taking no position instead of revealing their preferred policies; a low probability of being able to make an announcement can lead to the existence of the ambiguity equilibrium, even with Bayesian voters.

However, in the limit as γ approaches one, a Bayesian would infer that a candidate who takes no position offers a lottery over B/D and A/E. The median voter would prefer a candidate who announces to B/D to this lottery. Based on this voter preference, a candidate who prefers B/D would gain by deviating from taking no position to announcing B/D. Therefore, in the limit as γ goes to one, the ambiguity equilibrium does not exist as a Bayes-Nash equilibrium.

In contrast, when appealing to cursed voters, candidates who prefer B/D may choose to remain ambiguous.

Proposition 4. *In the limit as $\gamma \rightarrow 1$, the ambiguity equilibrium exists as a cursed equilibrium if and only if*

$$\chi \geq \chi_A \equiv \frac{\pi_A (u_2 - u_3)}{\pi_C [\pi_A (u_2 - u_3) + (1 - \pi_C) (u_1 - u_2)]} \quad (1.2)$$

As was the case with χ_{NR} above, it will be shown in Proposition 5 that $\chi_A \in (0, 1)$ when $\frac{\pi_A}{\pi_C} < \frac{u_1 - u_2}{u_2 - u_3}$. When this holds, there does exist a threshold value of cursedness; if the median voter's degree of cursedness is above the threshold, then the ambiguity equilibrium exists, even in the limit as γ approaches one.

If the median voter is sufficiently cursed, she believes that a candidate who took no position is fairly likely to prefer C, because she does not fully appreciate how candidate preferences affect their strategy choices. These distorted beliefs lead her to prefer a candidate who took no position to a candidate who revealed a preference for B/D. In response to the median voter's behavior, a candidate who prefers B/D optimally chooses to take no position, rather than announcing his policy preference.

In parallel to the case when the near-revelation equilibrium must exist, the fact that $\chi_A \geq 1$ when $\frac{\pi_A}{\pi_C} \geq \frac{u_1 - u_2}{u_2 - u_3}$ implies that, in this case, the ambiguity equilibrium does not exist for any degree of cursedness.

The next proposition establishes the conditions under which the near-revelation and ambiguity equilibrium are unique. As is clear from the conditions discussed above, the near-revelation equilibrium is the unique Bayes-Nash equilibrium in the limit as $\gamma \rightarrow 1$. However, depending on the value of χ , there may be multiple cursed equilibria.

Proposition 5. *In the limit as $\gamma \rightarrow 1$:*

1. *If $\frac{\pi_A}{\pi_C} < \frac{u_1 - u_2}{u_2 - u_3}$, then:*

(a) $0 < \chi_A < \chi_{NR} < 1$

(b) *The near-revelation equilibrium is unique if and only if*

$$\chi < \chi_A \equiv \frac{\pi_A (u_2 - u_3)}{\pi_C (\pi_A (u_2 - u_3) + (1 - \pi_C) (u_1 - u_2))}$$

(c) *The ambiguity equilibrium is unique if and only if*

$$\chi > \chi_{NR} \equiv \frac{(u_2 - u_3)}{(1 - \pi_A) (u_2 - u_3) + \pi_C (u_1 - u_2)}$$

(d) *The near-revelation and ambiguity equilibria both exist (and no other equilibria exist) if and only if $\chi_A \leq \chi \leq \chi_{NR}$*

2. If $\frac{\pi_A}{\pi_C} = \frac{u_1 - u_2}{u_2 - u_3}$, then the near-revelation equilibrium is unique if $\chi < 1$, and both the near-revelation equilibrium and the ambiguity equilibrium exist if $\chi = 1$.
3. If $\frac{\pi_A}{\pi_C} > \frac{u_1 - u_2}{u_2 - u_3}$, then the near-revelation equilibrium is unique, for all values of χ .

Let $\chi_{NR}(\pi)$ denote the threshold value of χ that determines whether the near-revelation equilibrium exists, and let $\chi_A(\pi)$ denote the threshold value of χ that determines whether the ambiguity equilibrium exists. The next set of results show how these thresholds are affected by changes in the distribution of candidate preferences and voters' risk preferences.

To analyze the effect of changing the distribution of candidate preferences, the next proposition considers an increase in the share of extremists, while reducing shares of moderates and centrists in fixed proportions.

Proposition 6. *Suppose that π_A increases by ε , while π_B decreases by $\lambda\varepsilon$ and π_C decreases by $(1 - \lambda)\varepsilon$ for $\lambda \in [0, 1]$. Then, χ_{NR} and χ_A increase.*

Recall that an increase in χ_{NR} implies that the near-revelation equilibrium is more likely to exist; similarly, an increase in χ_A implies that the ambiguity equilibrium is less likely to exist. This occurs when voters are less likely to vote for candidates who take no position. The distribution of policy preferences

matters in a straightforward way. If candidates who prefer A make up a larger fraction of the candidate pool, then it is more likely that a candidate who takes no position has that preferred position (and less likely that he has a position that is better for the median voter). Thus, a voter must really not understand the link between candidate type and strategy if she is still willing to vote for a candidate who takes no position.

The following proposition examines the role of risk-aversion in electoral outcomes. This chapter defines one set of preferences u as more risk-averse than another set of preferences v if and only if the certainty equivalent of any lottery is lower under u than under v .

Proposition 7. *Suppose that utility function u represents more risk-averse preferences than utility function v . Then χ_{NR} and χ_A are higher under u than under v .*

The ambiguity equilibrium requires that voters vote for a candidate who takes no position over a candidate who announces B/D. If a voter is too risk-averse, then even if cursedness leads her to believe that a candidate who takes no position is more likely to be a centrist than the candidate actually is, the voter may still be reluctant to take the risk associated with voting for the candidate who took no position. Cursedness and risk aversion thus work in opposite directions.

In this game, risk aversion of candidates does not play a role. Since a candidate will implement his preferred policy regardless of the strategy that he chooses, the two possible outcomes are winning the election and implementing his preferred policy and losing the election and having the opponent's preferred policy implemented. A candidate has the same ranking of his opponent's preferred possible preferred policies as the median voter does; Candidate 1 and the median voter prefer C to D and prefer D to E. This implies that there is no incentive for the candidate to decrease his overall winning probability in order to ensure that he defeats a certain type; if he is able to defeat the opponent candidate who is closest to his ideal point, he will also be able to defeat more extreme opponents. In sum, a candidate simply maximizes his probability of winning

the election; there is no risk-return trade-off.

1.3.5 Welfare

Proposition 5 showed that for a range of parameter values, the ambiguity equilibrium exists if the median voter is sufficiently cursed, while the near-revelation equilibrium exists if the median voter holds beliefs that are sufficiently close to Bayesian. Given that cursedness may lead to the ambiguity equilibrium being played instead of the near-revelation equilibrium, it is natural to consider the welfare consequences.

Proposition 8. *Suppose that the near-revelation equilibrium exists as a Bayes-Nash equilibrium and the ambiguity equilibrium exists as a cursed equilibrium. Then, as $\gamma \rightarrow 1$,*

- *The expected utility for players that prefer C and B/D is higher in the Bayes-Nash equilibrium than in the cursed equilibrium.*
- *The expected utility for players that prefer A/E is higher in the Bayes-Nash equilibrium than in the cursed equilibrium if and only if*

$$u_2 + u_4 > u_1$$

Note that, while the analysis focused on the median voter, who prefers C, other voters are distributed across the policy space. Therefore, one may care about the welfare effects on players that prefer B/D and A/E not because one cares about the candidates' welfare, but because many voters also hold those preferred policies. Proposition 8 applies in the case when $\frac{\pi_A}{\pi_C} < \frac{u_1 - u_2}{u_2 - u_3}$, when the cursed equilibrium is the ambiguity equilibrium (for sufficiently high χ), while the near-revelation equilibrium is the Bayes-Nash equilibrium. Note that in the limit as γ approaches one, the near-revelation equilibrium necessarily exists as a Bayes-Nash equilibrium, but the ambiguity equilibrium may not exist

as a cursed equilibrium for some parameter values. However, in the case when cursedness matters, the expected electoral outcome is worse for voters if the median voter is cursed than when she is Bayesian. Suppose that Candidate 1 prefers B and Candidate 2 prefers E. If the median voter knew these preferences, she would prefer to elect Candidate 1. If Candidate 1 chooses to announce his preferred policy, then, given that the median voter's beliefs about his strategy are correct, Candidate 1 would be elected if she is able to announce and will win with probability $\frac{1}{2}$ if she is prevented from announcing. However, if Candidate 1 chooses to take no position, then Candidate 1 and Candidate 2 would be equally likely to win the election. Clearly, having the information about Candidate 1's preferred policy benefits the median voter.

The welfare effects of cursedness on candidates that prefer A/E are ambiguous and depend on the shape of the utility function. It is particularly notable that candidates that prefer B/D—the ones that change their behavior when voters are cursed—would prefer to live in a world in which the median voter is a Bayesian. In other environments, one might talk about firms or politicians taking advantage of a behavioral bias to increase profit. To borrow an example from O'Donoghue and Rabin (2003), potato chip manufacturers are better off when consumers have present-biased preferences than when consumers are time-consistent. In contrast, moderate politicians take no position in response to the voters' behavior, but they would be better off if the voters understood incentives well enough to allow the moderate candidates to reveal their preferred policies.

The main takeaway of the announcement game is that, since candidates with different policy preferences have different incentives to announce their preferred policy, a decision to not make an announcement should reveal information to voters. If voters are cursed and do not appreciate the link between type and strategy, then they will not correctly take into account the candidates' actions when updating their beliefs. Sufficiently cursed voters will prefer a candidate who takes no position to one who announces a preferred policy of B/D. Candidates who prefer B/D will respond to the voters' behavior by not an-

nouncing a preferred policy. On the other hand, sufficiently Bayesian voters will not vote for a candidate who took no position if the opponent announced B/D; candidates who prefer B/D best-respond to their behavior by announcing B/D. The candidates' responses to voters' choices, which may derive from incorrect beliefs about the candidates, thus determine whether nearly all information about candidates is revealed in equilibrium or whether only candidates who share the median voter's policy preference choose to announce their preferred policies.

1.4 Commitment Game

While it may be reasonable to assume that candidates will always implement their preferred policies, it may be possible for a candidate to credibly make a binding commitment to instead put into place a different policy. This section considers the robustness of the results from the announcement game to the alternative assumption that candidates may make binding commitments to any policy. The structure of this game differs from the announcement game only in the campaign stage:

Stage 1: The candidates simultaneously choose campaign strategies. Candidate 1 may choose to make a binding commitment to policy A, B, or C or to take no position; Candidate 2 may choose to commit to policy C, D, or E or to take no position.

If a candidate is able to make a commitment to voters, he must implement the policy to which he committed if elected. If not, including if Nature prevented a commitment from being observed, he is free to implement his preferred policy if he wins the election.

Formally, a strategy for Candidate 1, $\sigma_1(\theta_1)$, is a mapping from preferred policy $\theta_1 \in \{A, B, C\}$ to campaign action $a_1 \in \{A, B, C, \emptyset\}$; he may choose to com-

mit to any policy⁶ or to take no position. As in the announcement game, a strategy for Candidate 2 is defined analogously. Definitions of Bayes-Nash and cursed equilibrium are not repeated here, as they are identical to those for the announcement game. The candidate strategies defined here simply replace the strategies with the limited action space defined in the announcement game.

Much of the intuition from the simpler announcement game described in the previous section also carries through. While the candidates have different incentives, the median voter's decision problem has not changed. Beliefs conditional on equilibrium strategies of candidates are not affected by the set of strategies that were not chosen. As in the announcement game, voters' beliefs about the preferred policy of a candidate who makes a policy commitment continue to be irrelevant. In this case, it is because commitments are binding. For instance, if a voter believes that no candidate will commit to A/E but observes that a candidate does so, her beliefs about the candidate who chose this off-path strategy do not affect her voting decision. In addition, the comparative statics regarding how risk aversion and the distribution of candidate preferences affect the relationship between cursedness and the decision to vote for a candidate who takes no position and a candidate who commits to B/D continue to hold.

Since candidates now have the option of committing to policies that are not their preferred policies, more equilibria are possible. In particular, there now exists a trade-off between choosing a strategy that would allow the candidate to implement a more preferred policy and choosing a strategy that would give the candidate a greater chance of winning the election⁷. Characterizing these equi-

6

For Candidate 1, committing to C dominates committing to D or E, since both the winning probability and payoff conditional on winning is higher if he commits to C. Excluding D and E from the action space is therefore without loss of generality.

7

This trade-off implies that candidates no longer have dominant strategies, because the probability of winning depends on the strategy chosen by the opponent. Therefore, the assumption that candidates are Bayesians matters in the commitment game, because cursed candidates do not correctly predict the policy that would be implemented by an opponent that does not take a position. However, this has a small effect on incentives, only slightly changing the degree of risk aversion that would lead a candidate to choose one strategy over another.

libria requires more work; to show the existence of a particular equilibrium, it is necessary to show that each type of candidate would not choose to deviate to any strategy in the now expanded strategy space. This chapter restricts attention to equilibria in pure strategies.

As was the case in the announcement game, candidates who prefer C will commit to C. While these candidates now have the option of committing to other policies, these other policies are less preferred by both the candidate and the voters; therefore, expanding the strategy space has no effect on these candidates. It also remains true that candidates who prefer A/E will not commit to A/E, for the same reason that they would not reveal A/E in the announcement game. Additionally, no type of candidate will commit to A/E, because doing so would be even less advantageous for a candidate who prefers a policy that is closer to what the voter prefers than A/E. Keeping these properties in mind allows one to consider fewer cases when analyzing possible equilibria. Equilibria will differ in terms of the strategies chosen by candidates who prefer B/D and A/E. This section begins with a discussion of when the near-revelation and ambiguity equilibria introduced in the previous section also exist in the commitment game.

Proposition 9. *In the limit as $\gamma \rightarrow 1$, the near-revelation equilibrium exists if and only if the following conditions hold:*

$$\chi \leq \chi_{NR} \equiv \frac{u_2 - u_3}{(1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2)} \quad (1.3)$$

$$\frac{2u_2 - u_1 - u_3}{u_1 - u_3} \leq \frac{\pi_A}{\pi_A + \pi_B} \quad (1.4)$$

$$\frac{\frac{1}{2}u_1 - u_4}{u_3 - u_4} \geq \frac{\pi_A + \pi_B}{\pi_A} \quad (1.5)$$

$$\frac{u_1 - u_2 - u_4}{u_2 - u_4} \geq \frac{\pi_A + \pi_B}{\pi_A} \quad (1.6)$$

Equation 1.3 ensures that voters vote for a candidate who committed to B/D when the opponent took no position; it is the condition that established the ex-

istence of the near-revelation equilibrium in the announcement game. Note that this implies that, when voters are Bayesians, this condition will always hold in the limit as $\gamma \rightarrow 1$. Cursedness affects the equilibrium played only through this condition; the others ensure that candidates do not deviate to other strategies. Since it is assumed that candidates are Bayesians, conditional on the median voter's equilibrium strategy, the candidates' decisions do not depend on χ .

Equations 1.4, 1.5 and 1.6 ensure that a candidate who prefers B/D will not deviate to committing to C, that a candidate who prefers A/E will not deviate to committing to C, and that a candidate who prefers A/E will not deviate to committing to B/D, respectively. A candidate who prefers B/D has no incentive to deviate to taking no position because by doing so, he would not affect the policy that he would implement conditional on winning and he would decrease his probability of winning.

In the announcement game, each candidate would implement his preferred policy regardless of the strategy chosen; he could only choose whether or not to announce that policy to voters before the election took place. In contrast, a candidate in the commitment game may choose to commit to a policy that is not his preferred policy in order to increase his chance of winning the election, thereby preventing his opponent from implementing an even worse alternative.

Risk aversion has an important effect on candidates' incentives, by influencing how candidates view the trade-off between the probability of winning the election and the payoff conditional on winning. Compared to other equilibria discussed below in which all types of candidates make commitments, the near-revelation equilibrium requires that a candidate who prefers A/E choose a more risky strategy. By doing so, he can win the election if he faces an opponent who has also taken no position, though, even if that happens, he still wins only half of the time. However, when he wins, he is able to implement his preferred policy. If he deviated to a less risky strategy, such as committing to B/D, he would win the election with higher probability, but he would have to implement a less-preferred policy if elected.

The following result establishes the conditions under which the ambiguity equilibrium exists in the commitment game.

Proposition 10. *In the limit as $\gamma \rightarrow 1$, the ambiguity equilibrium exists if and only if the following conditions hold:*

$$\chi \geq \chi_A \equiv \frac{\pi_A (u_2 - u_3)}{\pi_C [\pi_A (u_2 - u_3) + (1 - \pi_C) (u_1 - u_2)]} \quad (1.7)$$

$$\frac{u_1 + u_3 - 2u_2}{u_3 - u_4} \geq \frac{\pi_A}{\pi_A + \pi_B} \quad (1.8)$$

$$\frac{u_1 + u_4 - 2u_3}{u_4} \geq \frac{\pi_A}{\pi_A + \pi_B} \quad (1.9)$$

Given that equations 1.8 and 1.9 hold, candidates who prefer B/C and A/E, respectively, cannot improve their expected payoffs by deviating to committing to C. Neither candidate can benefit by deviating to committing to B/D because, by doing so, a candidate would decrease his probability of winning the election without increasing his payoff conditional on winning. Equation 1.7 is the condition that ensures that voters are sufficiently cursed, such that the median voter prefers a candidate who took no position to a candidate who committed to B/D; as in the announcement game, it cannot hold if voters are Bayesians.

In the commitment game, taking no position may not be the strategy chosen by candidates who prefer B/D, even if they believe that the voters prefer candidates who take no position to candidates who commit to B/D. Taking no position is again a risky strategy, since it allows him to implement his preferred policy if elected, but he risks receiving a low payoff if his opponent wins. This risk does not affect decision-making in the announcement game because the alternative is losing the election by revealing B/D and receiving the low payoff for certain.⁸ However, in the commitment game, a candidate who prefers B/D has

⁸

The low payoff is not certain, since Nature might intervene and cause the candidate's platform to be seen by voters as "no position." However, since the probability of this event does not depend on the strategy chosen, the independence axiom implies that the candidate can simply focus on the expected payoff differences between alternative strategies in the state of the world

the option of committing to C, which would guarantee him his second-favorite policy.

The remaining results in this section provide conditions under which equilibria that involve strategies that were not feasible in the announcement game exist. The discussion begins with definitions of these new possible equilibria.

- Definition 5.**
1. *Near-centrist equilibrium: Candidates who prefer B/D or C commit to C, and candidates who prefer A/E take no position. The median voter would vote for a candidate who took no position over a candidate who committed to B/D.*
 2. *Centrist equilibrium: All candidates choose to commit to policy C, regardless of type. Voters would vote for a candidate who took no position over a candidate who committed to B/D.*
 3. *Centrist-B equilibrium: All candidates choose to commit to policy C. Voters would vote for a candidate who committed to B/D over a candidate who took no position.*
 4. *Commitment I equilibrium: Candidates who prefer C commit to C, and candidates who prefer B/D or A/E commit to B/D. The median voter votes for a candidate who committed to B/D over a candidate who took no position.*

The following proposition establishes conditions under which each of these equilibria exist.

Proposition 11. *In the limit as $\gamma \rightarrow 1$:*

1. *The near-centrist equilibrium exists if and only if the following conditions hold:*

$$2u_2 - u_1 - u_4 \geq 0 \tag{1.10}$$

$$u_1 - 2u_3 \geq 0 \tag{1.11}$$

$$\frac{u_1 - u_2}{u_2 - u_3} \geq \frac{1 - \chi(1 - \pi_A)}{\pi_C \chi} \tag{1.12}$$

when Nature does not intervene.

2. *The centrist equilibrium exists if and only if*

$$u_2 \leq \pi_A u_3 + \pi_B u_2 + \pi_C u_1 \quad (1.13)$$

3. *The centrist-B equilibrium exists if and only if*

$$u_2 \geq \pi_A u_3 + \pi_B u_2 + \pi_C u_1 \quad (1.14)$$

4. *The commitment I equilibrium exists if and only if the following conditions hold:*

$$\frac{2u_2 - u_1 - u_3}{u_1 - u_3} \leq \frac{\pi_A}{\pi_A + \pi_B} \quad (1.15)$$

$$\frac{1}{2}u_2 + \frac{1}{2}u_4 - u_3 \geq 0 \quad (1.16)$$

$$u_2 \geq \pi_A u_3 + \pi_B u_2 + \pi_C u_1 \quad (1.17)$$

As described above, the ambiguity equilibrium may not exist because candidates who prefer B/D have an incentive to deviate to committing to C. The difference between the near-centrist equilibrium and the ambiguity equilibrium in terms of strategies is that the candidates who prefer B/D commit to C in equilibrium, even though voters continue to favor a candidate who took no position over a candidate who committed to B/D. In the announcement game, such voter behavior always led candidates that prefer B/D to take no position, resulting in the ambiguity equilibrium. However, once candidates are able to make commitments, candidates that prefer B/D respond to these beliefs by instead committing to policy C if they are sufficiently risk-averse. Taking no position and pooling with candidates that prefer A/E in order to implement his preferred policy if he wins is a risky strategy, compared to committing to C and receiving his second-best alternative for certain.

Choosing to commit to the median voter's preferred policy, as all candidates do in the centrist equilibria, is a safe strategy. When $\gamma < 1$, candidates may have

incentives to deviate because, given that all other candidates are committing to C, there is no downside risk associated with deviating to B/D or no position. Either the opponent commits to C (resulting in the same outcome regardless of the potential deviator's behavior) or the opponent is prevented from taking no position, giving a candidate who deviates a chance to win and implement his preferred policy. However, this potential gain from deviating disappears in the limit as $\gamma \rightarrow 1$.

The centrist and centrist-B behavior differ only in the voter behavior. Note that in this equilibrium, as well as in other equilibria in which all candidates choose to make commitments, voters' decisions are driven entirely by the distribution of candidate preferences and the voters' risk preferences. The median voter would vote for a candidate who took no position over a candidate who committed to B/D (if that off-path deviation were observed) if and only if she prefers a random draw from the distribution of candidates to having B/D implemented for certain. Cursedness can only make a candidate who took no position more attractive to voters if more extreme candidates are more likely to take no position than candidates whose preferences are more aligned with the voters'; it has no effect when all candidates choose to make commitments.

In the commitment I equilibrium, candidates who prefer B/D and A/E balance the two opposing forces of wanting to implement a policy close to their preferred policies and needing to win the election in order to do so. A candidate who prefers B/D optimizes by committing to his preferred policy, giving up some probability of winning relative to committing to policy C, while a candidate who prefers A/E commits to a policy that lies between his preferred policy and the median voter's preferred policy. In equilibrium, only centrist candidates commit to policy C. To a candidate who prefers A or B, this means that there is a fairly high probability that the opponent will commit to D, giving the candidate who prefers A or B a chance of being able to win the election and implement policy B. However, there is also a chance that the opponent will be able to implement policy D. This equilibria exists if candidates are willing to take that risk, rather than committing to the median voter's preferred policy.

For completeness, the Appendix gives conditions for the existence of two additional equilibria in pure strategies: one in which candidates who prefer B/D commit to C and candidates who prefer A/E commit to B/D (commitment II), and a counterintuitive equilibrium in which candidates who prefer B/D commit to B/D while candidates who prefer A/E commit to C (reverse commitment). However, in the limit as $\gamma \rightarrow 1$, these equilibria can also only occur if preferences over policies are consistent with risk aversion in one part of the policy space and risk lovingness in another part of the policy space.

The following proposition gives a uniqueness condition that applies when candidates are risk-averse. This corresponds to the case often considered in which agents minimize a convex loss function; deviations in the neighborhood of the preferred policy do not result in large utility losses, but larger deviations have much greater impacts.

Proposition 12. *Suppose that candidates are risk-averse over policies. Then, in the limit as $\gamma \rightarrow 1$:*

1. *The centrist equilibrium is the unique pure-strategies equilibrium if and only if*

$$u_2 \leq \pi_A u_3 + \pi_B u_2 + \pi_C u_1$$

2. *The centrist-B equilibrium is the unique pure-strategies equilibrium if and only if*

$$u_2 \geq \pi_A u_3 + \pi_B u_2 + \pi_C u_1$$

In the limit as γ approaches one, all candidates choose to commit to the median voter's preferred policy if they are risk-averse. Cursedness still makes taking no position more attractive; in the near-centrist equilibrium, voters would prefer a candidate who takes no position to one who commits to B/D, even though only extremists choose to take no position in equilibrium. However, taking no position is too risky, given that the safer strategy of committing to the voter's ideal point is available. In the announcement game, candidates who

prefer B/D or A/E could only choose between risky strategies; in that environment, cursedness plays an important role in determining whether moderate candidates choose to reveal their preferences to voters or to taken no position. In contrast, when candidates can make credible commitments to any policy, risk-averse candidates choose to commit to policy C, regardless of the voters' degree of cursedness.

1.5 Conclusion

To summarize, this chapter shows how the outcome of elections can be affected if voters do not understand the strategic incentives faced by candidates. If a candidate does not take a position, voters should infer something about his preferred policy from this action, assuming that candidates are not so risk-averse that they all commit to moderate or centrist policies. However, if voters do not make these inferences, then a candidate may respond by taking no position, even when he prefers a moderate policy.

A key difference between the stylized model and a real-world election is that, in actual elections, it is not always clear whether a candidate has taken no position on an issue or has not discussed a particular issue simply because it is not salient. In the model, there was a single policy dimension, and it was common knowledge that candidates would, with some objective probability, have the opportunity to commit to a position. Theoretically, the noise introduced in the model by randomly preventing candidates from committing works in a similar way as noise in the real world generated by uncertainty about issue salience. Think of candidates as having made a decision about a position (or lack thereof) on each issue at the beginning of the campaign. With some probability, an issue gains attention and the candidate's strategy is enacted. If not, voters do not observe that the candidate has taken a position on the issue. For example, if voters do not observe a candidate make a statement about international trade policy, they would be uncertain about whether the candidate has a campaign

plank on this issue that has not been revealed because of lack of media attention to the issue or whether the candidate intends not to take a position on trade policy. The primary difference here is that different types of issues have a different probability of being made salient. For instance, in modern U.S. elections, the probability that attention will be drawn to a candidate's position on moral issues such as abortion and gay marriage approaches one, while it is much less likely that the media will focus on potential nominees to obscure positions.

Additionally, candidates may be heterogeneous with respect to other characteristics that voters care about, such as integrity or decisiveness. Since such traits may also affect a candidate's decision about whether to remain ambiguous, a platform of "no position" can be a signal of both policy preference and other character traits. For example, a candidate who faces internal costs when making decisions about taking action may also face similar costs when deciding which policy to espouse during a campaign; taking no position would then be a signal of indecisiveness. An extension of the model to this more complicated signaling game is left for future work.

All unraveling arguments rely heavily on people's understanding of the incentives involved. While this idea was applied here to study political campaigns, it is relevant to many economic phenomena. An existing literature studies disclosure of various types of information, from reviews by film critics (Brown, Camerer, and Lovo 2012) to the quality and safety of a firm's products (Dranove and Jin 2010). It also has applications to lemons markets and auctions in which the seller has private information about the value of the good. If sellers are able to exploit individuals who are not able to understand this logic, then the standard information revelation results disappear. Further research is needed to determine how the presence of cursed individuals in a market can affect outcomes if some or even most people are Bayesians.

CHAPTER 2
ARE VOTERS CURSED WHEN POLITICIANS CONCEAL POLICY
PREFERENCES? EXPERIMENT

2.1 Introduction

This chapter discusses a laboratory experiment that tests whether the mechanism discussed in the previous chapter can generate ambiguity in elections as predicted by the theory. In real-world elections, isolating a particular mechanism for behavior is extremely difficult. In contrast, in the laboratory, other possible channels can be shut down. For instance, making the location of the median voter common knowledge removes uncertainty about the median voter's preference as a potential confound. Additionally, in the lab, preferences are induced by paying subjects depending on the outcome of the election; this greatly reduces the scope for electing a candidate based on some other dimension. Most importantly, the parameters of the game can be manipulated, which, as will be made clear later in the chapter, is key for the identification of partial cursedness. The experiment is also useful because, while theorists would prefer to write down theories that are portable across different contexts (Rabin 2013), whether a given theory actually does apply in a particular setting is an empirical question. As discussed below, evidence on the cursed equilibrium model is mixed, suggesting that people may do a better job understanding the strategic incentives that they face in some situations than in others. By recreating an election setting in the lab, one can find out whether cursedness affects people in this fairly familiar environment.

In the experiment, subjects play the commitment game described in the preceding chapter. Briefly, the model predicts that if voters are Bayesians, then the median voter would vote for a candidate who committed to B/D over a candidate who took no position; candidates who prefer B/D would then optimally choose to commit to B/D. On the other hand, if voters are sufficiently cursed, then in equilibrium, the median voter would vote for a candidate who takes

no position over a candidate who commits to B/D; candidates who prefer B/D would respond by taking no position¹. Subjects play 15 periods of this game, with the distribution of candidate preferred policies and the probability that Nature intervenes changing after every five periods. This changes the threshold degree of cursedness that determines whether moderate candidates choose to commit to their preferred policies or take no position. Analysis of the behavior as values of the parameters change puts bounds on the degree of cursedness that is consistent with subjects' choices. Subjects receive feedback modeled after the information revealed after real elections; they view vote counts, know who wins, and know what policy is implemented, but they do not know the true preferred policy of any candidate or what the losing candidate would have done.

To preview the main results, most subjects vote for a candidate who commits to a moderate policy over a candidate who takes no position. This implies that these subjects do understand the incentives. However, a significant fraction of subjects do vote for candidates who take no position over candidates who commit to a somewhat good policy from the voters' perspective in some circumstances, suggesting they are partially or even close to fully cursed. Surprisingly, many subjects do not vote for candidates who take no position even when the opponent commits to the worst possible policy for the voters. Several possible explanations for this reluctance to vote for an ambiguous candidate even in this circumstance are considered. As will be explained below, the behavior seems consistent with a model in which voters value character, which may mean that they prefer candidates who always commit to their preferred policies or candidates who are open about their policy intentions. Either way, taking no position signals a lack of character, and candidates who choose this strategy are punished at the polls.

In addition, the experiment sheds light on the mechanism behind cursed

1

This is true as long as risk aversion does not lead candidates to instead choose to commit to policies that are closer to what the median voter wants. The experiment uses parameterizations such that the predictions listed in the main text generally apply.

equilibrium. For example, one might hypothesize that uncertainty regarding whether *other* people understand the incentives matters; behavior that deviates from the Bayes-Nash prediction could be a rational response to a belief that others are making mistakes. While other work has used computerized players to control for this possibility, this experiment was designed to allow for comparisons of responses to fellow subjects and responses to computerized players. In two treatments, the candidates are randomly chosen from among the subjects. In the third, the candidates are programmed to play the Bayes-Nash equilibrium of the game: extreme candidates take no position and other types commit to their preferred policies. By comparing two treatments that are identical in every way except that the candidates are real subjects in one treatment and programmed to play as expected profit maximizers in the other treatment, one can test how much of the difference between observed behavior and the Bayes-Nash prediction is the result of uncertainty about the other players' rationality. In fact, subjects were much more likely to vote for a candidate who took no position in the treatment with programmed candidates than the treatments with subject-candidates. In addition, reported beliefs about candidate strategies were much more closely aligned with the strategies actually chosen when the candidates were fellow subjects. Guessing how other inexperienced subjects would play by introspection was probably easier for subjects than trying to learn the equilibrium of the game.

This study also confirms the value of taking advantage of the experimental setting to get data on beliefs, which are typically not available in field settings. In the programmed candidates treatment and one of the two subject-candidates treatments, voters' beliefs about the strategies that different types of candidates would choose and the likely preferred policy of a candidate who took no position are elicited before they vote. Because behavior does not differ significantly between two treatments that are identical except that one includes the belief elicitation and the other does not, prompting subjects to think about certain contingencies does not seem to affect their play in this experiment. Belief data can be used to confirm that behavior is consistent with the explanation proposed.

Data on beliefs turned out to be incredibly useful, since a model in which voters are cursed and one in which voters believe that all candidates make commitments to signal character generate identical predictions about behavior. The belief data can be used to separate out those subjects who believed that all candidates would commit, thus allowing for clean analysis of the remaining subjects' behavior. Among voters who do not believe that all types of candidates make commitments, the main result that a minority of voters support a candidate who takes no position over a candidate who commits to the second-best policy continues to hold.

The remainder of the chapter is organized as follows. Section 2.2 discusses how the chapter connects related literatures in experimental economics. Section 2.3 outlines the experimental design. Section 2.4 provides a framework for analyzing the results by explaining in more detail the predictions that the theoretical model makes for behavior in the experiment. Discussion of the results of the experiment can be found in section 2.5. In section 2.6, several explanations for why some subjects always avoid the candidate who took no position are considered. Finally, section 2.7 concludes.

2.2 Literature Review

This chapter speaks to an experimental literature on the limits of strategic thinking in games with incomplete information. This brief review of that literature focuses on papers that are most closely related to this work because they explicitly test the predictions of the cursed equilibrium model. The evidence is mixed, with researchers finding evidence of different levels of cursedness in different games. In an experiment that studies a different facet of voting behavior, Battaglini, Morton, and Palfrey (2010) find that most uninformed subjects do cast their votes strategically, taking into account the fact that others may be better informed. In contrast, in a simultaneous-move game in which players either compromise or fight after privately observing their strength, subjects behave in

a manner consistent with a high degree of cursedness, though their estimates do not allow for heterogeneity across people (Carrillo and Palfrey 2009). Charness and Levin (2009) reinvent the acquire-a-company game as a simple individual decision to eliminate uncertainty about other players and reduce the complexity of the problem. If interpreted as a game with sellers, the data are consistent with fully cursed equilibrium in some conditions, suggesting that uncertainty about other players' understanding of the game does not explain why behavior consistent with the cursed model is observed. However, they do not test whether partial cursedness could also (and potentially better) explain their results.

Papers that allow for heterogeneity in the degree of cursedness across people typically find that some subjects are more sophisticated than others. Brocas, Carrillo, Wang, and Camerer (2009) analyze choices and track which payoffs subjects choose to look at in several games. They find different levels of sophistication across subjects, with fully cursed equilibrium being able to explain the behavior of some subjects, though they also do not develop the predictions under the assumption of partial cursedness. Crawford and Iriberri (2007) is to my knowledge the only paper that estimates subject-specific values of the cursedness parameter while making appropriate restrictions regarding its possible values.² Using data from several experiments on different types of auctions, they find that almost half of subjects are fully cursed, about one fifth are Bayesians, and the rest are partially cursed to some degree.

This chapter contributes to the debate regarding how well people take others' strategic incentives into account when they make decisions. It also provides another test of the cursed equilibrium model, allowing both for partial cursedness and heterogeneity in the degree of cursedness, and shows that a combination of full understanding of incentives, full cursedness, and partial cursedness is needed to explain the results. However, as will be explained later in the paper, in this particular context, this behavioral bias is somewhat overshadowed

2

As was explained in the previous chapter, the cursedness parameter must lie between 0 and 1. Eyster and Rabin (2005) do not make this restriction in the empirical applications in their paper.

by other factors that lead subjects to avoid candidates who do not take a position.

Additionally, this work is part of a large and growing literature that uses experimental methods to test predictions of political economy models. For reviews of this literature, see McKelvey and Ordeshook (1990), Palfrey (2006), and Palfrey (2009).

2.3 Experimental Design

As shown in the previous chapter, the degree of cursedness is a key determinant of whether the near-revelation or ambiguity equilibrium is played. Further, for a given value of χ , the equilibrium played may change as the distribution of candidate preferences and the probability that a candidate is able to commit to a policy change. By manipulating these parameters and observing the resulting behavior, one can make inferences about the value of χ that is consistent with behavior in this election environment. The experiment described in this section is designed to do just that.

The experiment was programmed and conducted with the software z-Tree (Fischbacher 2007). This paper uses data from eighteen sessions run in the Business Simulation Lab at Cornell University between April 14 and April 28, 2013 and between July 7 and July 16, 2013, with 160 subjects.³ Participants were recruited through an online recruiting tool. Students and staff members who were interested in participating in studies at the lab could sign up for an account that

3

23 sessions with 212 subjects were run in total. However, a programming error discovered and fixed after the twelfth session caused the computer to draw from the wrong distribution of candidate preferences during parts of some sessions. If this error occurred at the beginning of the experiment, the entire session is excluded from analysis. If the error did not appear until later in the session, then data collected before the error are not affected by it and remain in the dataset. All analysis in this paper uses data that were not affected by the programming error, though this is the reason for smaller sample sizes in some treatment cells. The additional July sessions were added due to unexpectedly high no-show rates in the last week that the lab was open for the spring semester.

would allow them to gain access to a list of studies seeking subjects. As compensation, subjects received their choice of two units of extra credit (only relevant for students in a few business classes) or one unit of credit and a \$5 show-up fee, in addition to the incentive payments described below. Most students did not choose the additional credit option. Incentive payments ranged from \$5 to \$24.40, averaging \$15.70. Sessions varied in length, with some sessions ending in less than an hour and others hitting against the two-hour time constraint and having to end with fewer periods completed than planned.⁴ This typically occurred because one or two subjects took much more time to answer questions than subjects in pilot sessions.

During the experiment, participants played one of three variations of the election game. These variations will be referred to as treatments; each session is assigned to one treatment. Treatments differ in terms of whether a belief elicitation task is included and in terms of whether the candidate roles are played by subjects or by the computer. The three treatments are: subject-candidates with no beliefs, subject-candidates with beliefs, and programmed candidates with beliefs. Each treatment will be described in more detail below. While more than a third of subjects reported understanding the experiment completely and the vast majority didn't report major understanding problems, there were a handful of subjects who reported not understanding at all. 10 percent of participants in the programmed candidates treatment fall into the latter category, while only two percent of subjects in the subject-candidates with beliefs treatment did.

Demographic information about the subjects can be found in table 2.1. Most participants were undergraduates, though more than 10 percent of subjects were graduate or professional students and there were a few staff members. Subjects were generally similar across treatments. However, there were a couple of important differences. 30 percent of subjects in the programmed candidates

4

If time constraints required reducing the number of periods, subjects were told at the end of a condition that the previous period was the last one for that condition. Thus, periods in these sessions are still comparable to the same periods in other sessions, since subjects did not know ahead of time that a period would actually be the last period.

treatment had taken a course that covered game theory, while 42 percent of subjects in the subject-candidates with beliefs treatment had done so. Thus, while there were no differences that were statistically significant at five percent, it is possible that some of the differences between these two treatments may be the result of the fact that sessions with subject-candidates ended up having subjects with more experience with game theory.

The experiment consisted of four phases: an election game, a test of ability to use Bayes' Rule, tasks to measure risk aversion, and a demographic questionnaire. Screenshots from each phase, along with the instructions given to subjects, can be found in the Appendix.

Table 2.1: Demographics

	Subject Candidates, No Beliefs			Subject Candidates, With Beliefs			Programmed Candidates, With Beliefs		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Male	0.42	0.502	33	0.41	0.495	59	0.43	0.500	60
White	0.45	0.506	33	0.44	0.501	59	0.35	0.481	60
Asian	0.33	0.479	33	0.29	0.457	59	0.40	0.494	60
Age	21.82	2.920	33	20.90	1.873	59	21.63	5.039	60
Undergraduate	0.85	0.364	33	0.85	0.363	59	0.80	0.403	60
Grad/Professional Student	0.12	0.331	33	0.10	0.305	59	0.15	0.360	60
Not a Student	0.03	0.174	33	0.05	0.222	59	0.05	0.220	60
No Game Theory Knowledge	0.33	0.479	33	0.29	0.457	59	0.37	0.486	60
Took Game Theory Course	0.42	0.502	33	0.42	0.498	59	0.30	0.462	60
Never Studied Probability	0.12	0.331	33	0.12	0.326	59	0.20	0.403	60
Took Course in Probability	0.70	0.467	33	0.63	0.488	59	0.60	0.494	60
Completely Understood Experiment	0.33	0.479	33	0.39	0.492	59	0.35	0.481	60
Did Not Understand	0.06	0.242	33	0.02	0.130	59	0.10	0.303	60
Number of Subjects			41			59			60

Notes: The variable for "took game theory course" is equal to one if the subject reported taking a course in game theory or another course that covered game theory. The difference in whether subjects did not understand, between the treatments with belief questions and subject-candidates and the treatments with belief questions and programmed candidates, is marginally significant ($p=0.056$). Responses to demographic questions were not saved in some sessions due to a technical problem.

2.3.1 Election Game

The election game phase took most of the time for each session. The treatment with subject-candidates and no beliefs is described first, and an explanation of how the other treatments differ from this one follows. After receiving detailed instructions, participants play 15 periods of the game detailed below, divided into three conditions containing five periods each. The order in which subjects face the conditions are counterbalanced across sessions within each treatment. A condition is defined by the distribution of policy preferences and the amount of noise in the platforms that comes from candidates not being able to commit. In the low-noise skewed condition, $\pi_A = \frac{1}{2}$, $\pi_B = \frac{1}{4}$, and $\pi_C = \frac{1}{4}$, and candidates are able to commit with probability 0.9. The low-noise uniform condition uses the same commitment probability, but draws each preferred policy with equal probability. In the high-noise uniform condition, candidates are able to commit with probability 0.75, and all candidate types are equally likely. These values were chosen to satisfy two requirements. First, the numbers had to be familiar to subjects to avoid confusion—the denominator of each fraction is either two, three, four, or ten. Second, given these sets of values, a model with partially cursed voters has different predictions than a model with only fully cursed and/or Bayesian voters; these predictions will be discussed in detail in the next section.

Each period contains the following stages:

Role screen: At the beginning of each period, two subjects are randomly chosen to be candidates. The remaining subjects play the role of voters. The first screen that each subject sees tells him his role for the period, his preferred policy (if he is a candidate), the preferred policy of voters, the distribution from which candidate types are drawn, and the probability that a candidate who tries to commit will be able to do so successfully.

Candidate strategy choices: Each candidate chooses a campaign strategy by clicking a radio button. As in the commitment game described in section 1.4, a

candidate may choose to make a policy commitment or to take no position.

Voter choices: The strategy method is used to learn which candidate each subject would vote for given any possible combination of candidate platforms. The instructions emphasize that a candidate's platform is "no position" if the candidate chose to take no position or if the computer intervened and randomly prevented the candidate from making a commitment. Subjects have the option of abstaining in each case, and they are told that they may use it if they like both candidates equally. This option was added after pilot subjects reported being confused about how to respond in such cases and were very concerned about giving Candidate 1 an unfair advantage.

Election results: To determine the outcome of the election, the votes that correspond to the candidates' platforms are counted. If the winner made a commitment, that commitment is honored. If not, the winner's preferred policy is implemented. Subjects see an outcome screen that lists each candidate's platform, the number of votes received by each candidate, the winner of the election, the policy implemented, and the number of points earned by the subject in that period. In each period, all subjects receive points based on the payoff chart shown below in table 2.2; this chart was given to subjects with the instructions.

Table 2.2: Election Game Payoffs

		Implemented Policy				
		A	B	C	D	E
Preferred Policy	A	10	4	2	1	0
	B	4	10	4	2	1
	C	2	4	10	4	2
	D	1	2	4	10	4
	E	0	1	2	4	10

Subjects gain experience with the game by playing five practice periods after reading most of the instructions. In these periods, the strategy method is not used. Instead, candidates enter their strategies first, and voters only have to decide which candidate they prefer based on those candidates' actual platforms. This allows them to get a feel for the game before they receive the rest of the instructions, which explain how the strategy method works. A box appears at the top of the decision screens to remind subjects of the information presented on the role screen. Participants may also use a calculator by clicking on a calculator icon that appears at the bottom of all decision screens. One period is randomly chosen for cash payment at the end of the experiment, and points are converted one-for-one into dollars.

In the subject-candidates with beliefs and programmed candidates treatments, beliefs are elicited from voters in each period, before the voter choices stage. This is not done in one treatment, because there is some evidence that prompting people to think in a certain way by eliciting beliefs leads them to change their behavior (see Rutström and Wilcox (2009) and references therein). A comparison of the subject-candidates with no beliefs and subject-candidates with beliefs treatments will verify whether just asking these belief questions causes changes in behavior. In the belief elicitation, subjects are first asked which strategy they think the candidates will play, depending on their preferred policies. This is a direct test of cursedness, since it does not confound the assumption that people understand strategic incentives with the ancillary assumptions that people understand how to use prior beliefs when updating and that they incorporate the noise correctly. Next, subjects give their posterior beliefs that a candidate who has taken no position has each possible preferred policy. Subjects answer these questions in one of two ways. They may answer these questions by moving sliders that correspond to possible strategies or policy preferences. The further to the right a subject moves a slider, the more likely he believes the candidate will choose the strategy or has the policy preference associated with that slider. The computer calculates probabilities based on the distance each slider was moved as a fraction of the total distance moved by

all of the sliders. These probabilities are updated on the screen. This allows people who do not understand probabilities to answer the questions in an intuitive way. If subjects prefer to enter probabilities directly, they may click a radio button to switch the input mode. Subjects have three minutes to complete this screen, and they may click on an icon to bring up a calculator.

The belief incentivization procedure is based on that developed by McKelvey and Page (1990). Details can be found in the Appendix. If a subject is asked for her beliefs about the preferred position of a candidate who takes no position and that candidate actually takes no position, the subject takes part in a lottery. The probability that the subject wins the lottery is increasing in the accuracy of the subject's reported beliefs. The subject maximizes her expected payoff by reporting truthfully as long as she prefers winning the lottery to losing it; no risk neutrality assumption is needed. Similar lotteries are used to incentivize beliefs about strategies; for these, the distance between the subject's beliefs about that candidate's strategy given the realized type and the candidate's actual strategy is used to compute the probability of winning. In order to ensure that simply entering more lotteries (because candidates took no position more often) doesn't increase payoffs, subjects are paid the proportion of the entered lotteries that they win multiplied by \$3.

In the programmed candidates treatment, all subjects always take the role of voters, and the candidate roles are played by the computer. Subjects are told (truthfully) the payoffs of the candidates, as in the other treatments, and they are told that the candidates are programmed to choose decisions that would maximize their expected profits, assuming that the voters are also maximizing their expected profits. The purpose of this treatment is to address the concern that subjects may not play the equilibria described above because they do not believe that candidates are playing optimally. It also removes uncertainty about the risk preferences of the candidates. By controlling what subjects believe about the candidates, this treatment eliminates this as a possible explanation. In this treatment, one is able to interpret cursedness as a mistake, not as a possibly reasonable belief that candidates are making mistakes. Differences in behavior

between the subject-candidates with beliefs and programmed candidates treatments would be due only to the use of programmed candidates.

The remaining phases are the same for all treatments.

2.3.2 Test of ability to use Bayes' Rule

Subjects complete a task that is designed to test whether, given candidates' strategies and the distribution of possible candidate types, they are able to determine the posterior probability that is a candidate who took no position is of each type. Subjects answer six such questions, presented in random order. In three of the questions, subjects are told that the candidate (always Candidate 1) takes no position if his preferred position is A, chooses B if he prefers B, and chooses C if he prefers C. In the other three questions, they are told that the candidate chooses C if he prefers C and takes no position otherwise. Within each set of three, the prior probabilities of candidate types and the amount of noise vary as they do in the election conditions. For this task, subjects enter a lottery corresponding to each question, and the chance of winning the lottery is increasing in how close their reported probabilities are to the true probabilities. See the Appendix for details. Subjects are paid their winning percentage in the lotteries multiplied by \$2.

2.3.3 Tasks to measure risk aversion

Subjects complete two tasks designed to measure risk aversion; however, this chapter focuses on one task. In this task, subjects make six choices between a lottery and four points. These choices are based on choices that a voter would face if one candidate took no position and the other candidate committed to policy B/D; the lottery always has some probability of receiving two points, four points, and ten points. The task is fairly easy for subjects to understand, but it gives coarse information about risk preferences. The other task uses a BDM

(Becker, Degroot, and Marschak 1964) mechanism that allows for more precise estimates of risk aversion, assuming that subjects understand the more complex task. Subjects make four decisions. For each one, subjects are given a choice between a lottery that pays some sum if they win and nothing if they lose and a smaller sum for sure. They are asked for the lowest probability of winning that would still be high enough to induce them to choose the lottery. The computer then draws the probability of winning the lottery from a uniform distribution on $[0, 1]$, and the subject's choice is implemented. Subjects complete these two risk tasks in random order. They see the results of both tasks after both have been completed. One of the ten choices from these risk tasks is randomly chosen for payment, with points converted one-for-one to dollars.

2.3.4 Demographic questionnaire

While incentive payments are tabulated, subjects complete a brief questionnaire. It includes questions about standard demographic variables, such as age and gender, as well as questions about the subjects' experience with game theory and their understanding of the experiment.

2.4 Using model predictions to look for evidence of cursedness

This section builds a bridge between this and the preceding chapter, moving from fairly abstract theoretical results to testable predictions. As will be illustrated below, manipulation of parameters changes the threshold degrees of cursedness that determine equilibrium behavior. While the theoretical results discussed in the previous chapter focus on the limit case as the probability that a candidate will be able to make a policy commitment if he chooses goes to one, the experiment utilizes this probability to change candidates' incentives.

The existence of each possible equilibrium depends on the distribution of candidate preferences and the probability that Nature will prevent a candidate

from making a policy commitment, as well as preferences over policy outcomes. In the theory chapter, preferences over policy outcomes were primitives of the model. However, in the experiment, subjects receive monetary payments that depend on the outcome of the election, and they have preferences over these monetary amounts. To match the laboratory behavior, the model must take preferences over money as primitive, which requires some additional notation. Let x denote a player's election game payoff. Consistent with the theory outlined in the previous chapter, the monetary payoffs used in the experiment depend only on the distance between preferred policy and policy implemented. The payoffs shown in table 2.2 reflect an assumption that players care intensely about receiving their most preferred alternative and are less sensitive to differences between policies further away from their ideal points. Combined with anticipated risk aversion with respect to monetary amounts, preferences over policies derived from those preferences induced using monetary payments were expected to be approximately risk-neutral.

Each player's preferences over these payoffs can be represented by a Bernoulli utility function $u(x)$ that is increasing in x . In numerical calculations, it is assumed that $u(x) = \frac{1}{\alpha} (1 - \exp(-\alpha x))$, where α is the coefficient of absolute risk aversion. Assume that $\alpha = \alpha_c$ for each candidate and that all voters share $\alpha = \alpha_v$. It often makes sense to assume that $\alpha_c = \alpha_v$, particularly in the experimental treatments in which voters and candidates are drawn from the same pool of subjects. However, it is instructive to distinguish between the two because candidate and voter risk aversion matter in different ways for the results. Each candidate faces uncertainty because he does not know the preferred policy of his opponent when he chooses his strategy. Voters may face uncertainty because they do not know what policy a candidate who takes no position will implement. Additionally, programmed candidates are risk-neutral, while the subject-voters may have different risk preferences.

Table 2.3 shows which equilibria exist within each condition, as a function of

Table 2.3: Model Predictions

Abbreviations:					
NR : Near-revelation equilibrium					
Amb : Ambiguity equilibrium					
CI : Commitment I equilibrium					
Parameter Values			Possible Equilibria		
Candidate Risk Aversion	Voter Risk Aversion	Voter Cursedness	Low-Noise Skewed	Low-Noise Uniform	High-Noise Uniform
$\alpha_c = -0.07$	$\alpha_v = -0.07$	$\chi = 0$	NR	NR	NR,Amb
		$0 < \chi < 0.22$	NR	NR	Amb
		$0.22 \leq \chi \leq 0.33$	NR	NR,Amb	Amb
		$0.33 < \chi < 0.51$	NR	Amb	Amb
		$0.51 \leq \chi \leq 0.59$	NR,Amb	Amb	Amb
		$\chi > 0.59$	Amb	Amb	Amb
$\alpha_c = 0$	$\alpha_v = 0$	$\chi < 0.15$	NR	NR	NR
		$0.15 \leq \chi \leq 0.19$	NR	NR	NR,Amb
		$0.19 < \chi < 0.34$	NR	NR	Amb
		$0.34 \leq \chi \leq 0.46$	NR	NR,Amb	Amb
		$0.46 < \chi < 0.69$	NR	Amb	Amb
		$0.69 \leq \chi \leq 0.75$	NR,Amb	Amb	Amb
	$\alpha_v = 0.105$	$\chi < 0.40$	NR	NR	NR
		$0.40 \leq \chi \leq 0.49$	NR	NR	NR,Amb
		$0.49 < \chi < 0.54$	NR	NR	Amb
		$0.54 \leq \chi \leq 0.66$	NR	NR,Amb	Amb
		$0.66 < \chi < 1$	NR	Amb	Amb
		$\chi = 1$	Amb	Amb	Amb
	$\alpha_v = 0.154$	$\chi < 0.54$	CI,NR	NR	NR
		$0.54 \leq \chi \leq 0.63$	CI,NR	NR	NR,Amb
		$0.64 \leq \chi \leq 0.75$	CI,NR	NR,Amb	Amb
		$\chi > 0.75$	CI,NR	Amb	Amb
$\alpha_c = 0.105,$ $\alpha_c = 0.154$	$\alpha_v = 0.105$	$\chi < 0.40$	none	none	none
		$0.40 \leq \chi < 0.54$	none	none	Amb
		$0.54 \leq \chi < 1$	none	Amb	Amb
		$\chi = 1$	Amb	Amb	Amb
	$\alpha_v = 0.154$	$\chi < 0.54$	CI	none	none
		$0.54 \leq \chi < 0.64$	CI	none	Amb
		$\chi \geq 0.64$	CI	Amb	Amb

candidates' and voters' risk aversion. The table shows only cases in which candidates and voters have the same degree of risk aversion, plus cases in which candidates are risk-neutral, as they are in the programmed candidates treatment. The values of α used in these calculations were selected because they correspond to bounds that can be identified using the binary risky decision task. As only a handful of subjects made choices consistent with higher levels of risk aversion or with more risk-loving preferences (see Figure 2.1), predictions based on the risk preferences of these outliers are not included in the table.

Given these parameter values, the only equilibria that are consistent with low levels of risk aversion are the near-revelation and ambiguity equilibria. However, if candidates are sufficiently risk-averse, then the commitment I equilibrium exists, regardless of how cursed voters are. If this is the case, then voters may choose a candidate who commits to B/D over an opponent who takes no position either because they are sufficiently Bayesian and are playing the near-revelation equilibrium *or* because they face sufficiently risk-averse candidates and are playing the commitment I equilibrium. Since this situation can only arise in the low-noise skewed condition, it will not be discussed further. However, the reader should keep in mind that the extent of cursedness may be underestimated in this condition.

One can use table 2.3 to think about how simple comparisons of average behavior across different conditions can be used to learn something about cursedness. By considering parameter values for which an equilibrium may exist, even if it is not unique, it is still possible to draw conclusions about the value of the cursedness parameter, given that behavior consistent with that equilibrium is observed. Suppose that voters vote for a candidate who commits to B/D over a candidate who takes no position in all conditions. This can happen only if the near-revelation equilibrium exists in all conditions. If voters are also risk-neutral, this would result only if $\chi \leq 0.20$. If a greater degree of risk-aversion is assumed, the bound on χ increases, to $\chi \leq 0.50$ if $\alpha_v = 0.105$. Now, suppose that the opposite occurs: voters prefer the candidate who took no position in all conditions. This means that the ambiguity equilibrium must exist in all condi-

tions. If voters are risk-neutral, this can only happen if $\chi \geq 0.69$. This threshold also moves up, such that only a fully cursed voter would vote for the candidate who took no position in all three conditions if $\alpha_v = 0.105$. However, suppose voters vote for the candidate who takes no position in the low-noise uniform and high-noise uniform conditions, and it is assumed that $\alpha = 0.105$. Then, one can conclude that $\chi \geq 0.53$.

Now, consider what would be observed if there were two types of subjects: Bayesians and fully cursed subjects. In this case, the Bayesians would vote for the candidate who committed to B/D in all conditions, while fully cursed subjects would vote for the candidate who took no position in the low-noise uniform and high-noise uniform conditions, while voting for the candidate who committed to B/D in the low-noise skewed condition if they were sufficiently risk-averse. This would imply that, in the low-noise uniform and high-noise uniform conditions, the vote share of a candidate who took no position would be strictly between zero and one, and this vote share would be constant across these conditions. However, if differences in this vote share across the low-noise uniform and high-noise uniform conditions are observed, then it must be that at least some voters are partially cursed.

Finally, suppose that there is heterogeneity among subjects, with subjects having varying levels of cursedness and at least some subjects being partially cursed. The reader might think of subjects' behavior as being drawn from different rows in the table, depending on their risk aversion and cursedness. There are many rows that predict voting for B/D in the low-noise skewed column, fewer rows that predict this in the low-noise uniform column, and even fewer that predict this in the high-noise uniform column. Thus, as this heterogeneous group of subjects moves through the conditions, it would be expected that the vote share for candidates who take no position would increase from the low-noise skewed condition, to the low-noise uniform condition, to the high-noise uniform condition.

The above analysis assumed that candidates are risk-neutral. As shown in

the lowest two blocks of the table, if candidates are somewhat risk-averse, an equilibrium does not exist if voters are Bayesians. To address behavior here, equilibria in mixed strategies have been partially characterized, and this analysis appears in the Appendix. The main result is that, in each condition, there does not exist an equilibrium in mixed strategies in which voters strictly prefer a candidate who takes no position to one who commits to B/D. Therefore, observing that voters choose a candidate who takes no position must indicate cursedness, *not* that agents are risk-averse and are playing a mixed-strategy equilibrium that generates the same behavior.

In summary, the following conclusions can be drawn given data on average vote shares across conditions:

1. If votes are cast for a candidate who took no position over a candidate who committed to B/D, then the hypothesis that all subjects are Bayesians can be rejected.⁵
2. If votes are cast for a candidate who committed to B/D over a candidate who took no position, then the hypothesis that all subjects are fully cursed can be rejected.
3. If vote shares remain constant across conditions, then the data is consistent with a group of subjects who are approximately Bayesian and another group of subjects who are close to fully cursed.
4. If the vote share for the candidate who took no position increases from the LS to LU and/or from the LU to HU conditions, then there exists a group of subjects who are partially cursed.

5

With noisy data and response error, this feature of the data does not necessarily reject the Bayesian model. However, if observed in a subsample with very low response error, this is inconsistent with all subjects being Bayesians.

2.5 Results

2.5.1 Aggregate results

Choices between a candidate who committed to B/D and a candidate who took no position across conditions

If all voters behave according to the Bayesian prediction, then the vote share for the candidate who took no position when his opponent committed to B/D would be zero in all conditions. This null hypothesis is clearly rejected in the data. Averaging across all treatments and conditions, subjects voted for the candidate who took no position 24.5 percent of the time, voted for the candidate who committed to B/D 72.9 percent of the time, and abstained 2.7 percent of the time. To look at differences between conditions and across experimental treatments, the following estimating equation is used:

$$y_{ijt} = \sum_{k \in \{1,2,3\}} \sum_{l \in \{LS,LU,HU\}} \beta_{kl} Treatment_k Condition_l + \gamma Candidate1_{ijt} + \varepsilon_{ijt}$$

The dependent variable is a dummy variable equal to one if subject j in period t voted for candidate i if that candidate took no position when the opponent committed to B/D and equal to zero if the subject abstained or voted for the candidate who committed to B/D. In each period in which he is a voter, a subject is observed making two such choices: between Candidate 1 (B) and Candidate 2 (no position) and between Candidate 1 (no position) and Candidate 2 (D). i is the label (1 or 2) of the candidate who took no position. Results of OLS regressions⁶ are shown in table 2.4. Standard errors are clustered at the subject level.

The regressors that are included in all specifications are interactions of a dummy variable for the treatment (subject-candidates without belief questions,

⁶

Since all regressors are binary variables, the coefficients from the linear probability model are the same as the marginal effects that would be calculated if a probit or logit model were used.

subject-candidates with belief questions, or programmed candidates with belief questions) with a dummy variable for the condition (low-noise skewed, low-noise uniform, or high-noise uniform). This specification allows changes in the parameter values to affect behavior differently in each treatment. One might expect that subjects would be more attentive to changes in the parameter values when they were prompted to form beliefs before making their choices, or that the pattern of switching to a different candidate as the condition changes might differ when the candidates are programmed. The marginal effects of moving from one treatment to another, averaging across conditions, and from moving from one condition to another, averaging across treatments, are also given in the bottom panel of the table. *Candidate1*_{ijt} is equal to one if the candidate who took no position is labeled Candidate 1 and equal to 0 if that candidate is labeled Candidate 2. It is included in columns 2 and 4 to capture any bias toward choosing the candidate listed first, though no statistically significant bias is found.

In all treatment-condition combinations, the proportion of votes cast for the candidate who took no position was significantly greater than zero. In the subject-candidates with no beliefs treatment, this vote share increased from 8.6 percent in the low-noise skewed condition to 18.5 percent in the low-noise uniform condition ($p=0.03$), while there was no significant difference between the low-noise uniform and high-noise uniform conditions. In the treatment with subject-candidates and beliefs, there was no significant difference between the low-noise skewed and low-noise uniform conditions, but the vote share increased from 10.1 percent in the low-noise uniform condition to 19.3 percent in the high-noise uniform condition ($p=0.02$). In the treatment with programmed candidates, there was also no difference between the low-noise skewed and low-noise uniform conditions, while the vote share increased from 33.5 percent in the low-noise uniform condition to 40.5 percent in the high-noise uniform condition ($p=0.05$). Taking all treatments together, the vote share increased by 7.7 percentage points from low-noise uniform to high-noise uniform conditions ($p=0.02$).

If one takes the model seriously, the vote share for candidates who took no position in the low-noise skewed condition gives an estimate of the fraction of

Table 2.4: Proportion of Votes That Were For A Candidate Who Took No Position Over A Candidate Who Committed To B/D

		(1)	(2)	(3)	(4)
Subject Candidates, No Beliefs	Low-Noise Skewed	0.086*** (0.033)	0.079** (0.033)	0.100*** (0.037)	0.093** (0.038)
	Low-Noise Uniform	0.185*** (0.057)	0.178*** (0.057)	0.201*** (0.064)	0.194*** (0.064)
	High-Noise Uniform	0.252*** (0.062)	0.244*** (0.062)	0.281*** (0.068)	0.274*** (0.068)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.121*** (0.043)	0.114*** (0.043)	0.121*** (0.045)	0.114** (0.045)
	Low-Noise Uniform	0.101*** (0.025)	0.094*** (0.025)	0.104*** (0.027)	0.097*** (0.027)
	High-Noise Uniform	0.193*** (0.040)	0.186*** (0.040)	0.180*** (0.039)	0.173*** (0.039)
Programmed Candidates, With Beliefs	Low-Noise Skewed	0.340*** (0.053)	0.333*** (0.053)	0.360*** (0.055)	0.353*** (0.055)
	Low-Noise Uniform	0.335*** (0.057)	0.328*** (0.057)	0.355*** (0.061)	0.348*** (0.061)
	High-Noise Uniform	0.405*** (0.056)	0.398*** (0.056)	0.435*** (0.058)	0.428*** (0.058)
Candidate 1			0.014 (0.012)		0.014 (0.013)
R-Squared		0.29	0.29	0.31	0.31
N		3494	3494	3222	3222
(# of subjects)		(160)	(160)	(147)	(147)
Marginal Effects					
Subject Candidates, No Beliefs		0.042 (0.054)	0.042 (0.054)	0.065 (0.059)	0.065 (0.059)
Programmed Candidates, With Beliefs		0.222*** (0.056)	0.222*** (0.056)	0.249*** (0.058)	0.249*** (0.058)
Low-Noise Skewed		-0.014 (0.026)	-0.014 (0.026)	-0.014 (0.028)	-0.014 (0.028)
High-Noise Uniform		0.077*** (0.023)	0.077*** (0.023)	0.079*** (0.024)	0.079*** (0.024)

Notes: The dependent variable is a dummy for voting for the candidate who took no position when the opponent committed to B/D. Models estimated using OLS. Subjects who made choices in the binary risky decision task consistent with $\alpha \geq 0.305$ are excluded from the sample in models 3 and 4. Standard errors clustered at the subject level. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. In all specifications, differences between the LS and LU conditions are significant only in the no beliefs treatment ($p < 0.05$). Differences between the LU and HU conditions are significant in the subject-candidates with beliefs treatment ($p < 0.05$) and programmed candidates treatment ($p < 0.04$). Differences between the subject-candidates with beliefs and programmed candidates treatments were significant in each condition ($p < 0.01$). There were no significant differences between the two treatments with subject-candidates. Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, With Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform."

votes cast by subjects whose χ is above the highest threshold, close to 1. While this design can only give bounds on χ , this model combined with the data does indicate that voting behavior in the subject-candidate with beliefs treatment is consistent with a model in which 12 percent of votes are cast by voters who are fully (or almost fully) cursed, and behavior in the programmed candidates treatment suggests that 34 percent of votes are cast by voters behaving as if (almost) fully cursed. At the other end of the spectrum, the vote share for candidates who committed to B/D in the high-noise uniform condition gives an estimate of the fraction of votes cast by subjects whose χ is below the lowest threshold, close to zero. By subtracting the coefficients on the interactions with the high-noise uniform condition from one, one can infer that 75-81 percent of votes were cast by subjects who are approximately Bayesian in the treatments with subject-candidates, while 60 percent of votes were cast by Bayesians in the programmed candidates treatment.

Differences between conditions indicates that some subjects have a χ that implies playing one equilibrium in one condition, then switching to playing another equilibrium in another condition. The significant difference between low-noise skewed and low-noise uniform rounds in the treatment with no beliefs suggests that some subjects switched there. The following calculations assume risk neutrality. To see how the conclusions depend on the assumption about risk preferences, consult table 2.3. Under the assumption that the near-revelation equilibrium is played whenever both it and the ambiguity equilibrium exist, a difference between low-noise skewed and low-noise uniform rounds implies that some subjects made choices consistent with $0.46 \leq \chi \leq 0.75$. If one instead assumes that the ambiguous equilibrium is played whenever both it and the near-revelation equilibrium exist, this implies that $0.34 \leq \chi \leq 0.69$. In the other two treatments, the switch happened between the low-noise uniform and high-noise uniform conditions. Assuming that the near-revelation equilibrium is played whenever it exists, this implies that the partially cursed subjects changing behavior have a lower $0.19 \leq \chi \leq 0.46$. This range shifts to $0.15 \leq \chi \leq 0.34$ if one assumes that the ambiguity equilibrium is played if it exists.

Accounting for risk aversion

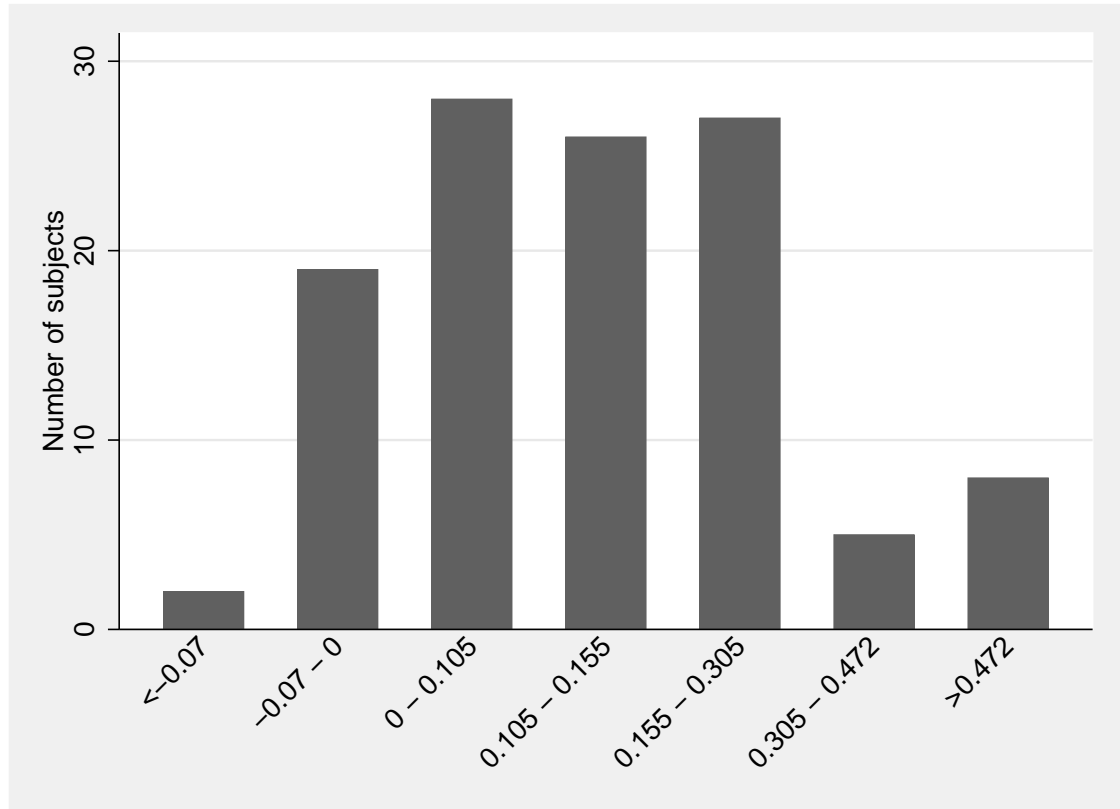
Recall that while the predictions discussed above hold for some levels of risk aversion, one would not expect to observe even fully cursed voters supporting a candidate who took no position if they were too risk-averse. To focus attention on the subjects for whom these predictions apply, choices in the binary risky decision task can be used to identify subjects who are too risk-averse for those predictions to apply to them. Recall that subjects faced six choices between receiving four points for sure and a lottery that paid two points, four points, or ten points. Denote the probability of receiving two points in question j by p_j and denote the probability of receiving ten points in question j by q_j . Individual i would choose the lottery if and only if $p_j u_i(2) + (1 - p_j - q_j) u_i(4) + q_j u_i(10) \geq u_i(4)$, where $u_i(x) = \frac{1}{\alpha_i} (1 - \exp(-\alpha_i x))$.⁷ A subject's choices in this task imply bounds on his coefficient of absolute risk aversion, α_i . A histogram of these coefficients can be found in figure 2.1. Bounds were not constructed for 44 subjects because their choices were inconsistent or for one subject who left the experiment before beginning the risky decisions tasks. Among the remaining subjects, the median lies between 0.105 and 0.155. 13 subjects made choices consistent with $\alpha \geq 0.305$; these subjects are classified as too risk-averse for the experiment to say anything about cursedness, since subjects with this level of risk aversion would always choose a candidate who committed to B/D regardless of the degree of cursedness.

Columns 3-4 of table 2.4 show results of the same regressions as columns 1-2, except that the subjects who were classified as too risk-averse are excluded from the sample. The vote shares for the candidate who took no position increase slightly, and they now range from 10.0 percent for the low-noise skewed condition in the no belief treatment to 43.5 percent in the high-noise uniform condition in the programmed candidate treatment. Including this control does not change the results regarding differences between conditions and between

7

Initial wealth is implicitly assumed to be zero, perhaps not an unrealistic assumption for undergraduate subjects.

Figure 2.1: Distribution of Coefficient of Absolute Risk Aversion



Notes: This figure shows the number of subjects who made choices in the binary risky choice task that are consistent with each coefficient of absolute risk aversion parameter range. Subjects who made inconsistent choices are not included in the figure.

treatments.

Differences between treatments

There were no significant differences between the two treatments with subject-candidates. This suggests that simply asking the belief questions did not cause subjects to behave differently. There are several possible differences between the treatment with subject-candidates with beliefs and the treatment with programmed candidates. First, while the programmed candidates behaved as a

risk-neutral candidate would, subject-candidates most likely were somewhat risk-averse. However, risk-neutral candidates and somewhat risk-averse candidates behave very similarly. The difference is that where the near-revelation equilibrium existed with risk-neutral candidates, there is no equilibrium in pure strategies with risk-averse candidates. However, the equilibrium in mixed strategies also cannot involve voters supporting a candidate who took no position. Thus, differences in candidate risk-aversion should not lead to differences in voter behavior across the two treatments.

The main difference is that, while subjects know that the programmed candidates are responding optimally, they may be uncertain about whether the subject-candidates are able to do so. In this case, the interpretation of cursedness could be that voters believe that candidates sometimes draw from the average distribution of strategies, not because the voters don't understand the incentives, but because the voters believe that the candidates don't understand the incentives. This would imply that, conditional on a subject's ability to understand the incentives, the behavior would be consistent with a higher level of cursedness in the subject-candidates with beliefs treatment. Therefore, if these beliefs about others' understanding of the incentives were driving cursed behavior, then we would expect to see the ambiguous candidate get a higher vote share in the subject-candidates with beliefs treatment. However, having programmed candidates actually significantly increased the likelihood that voters would choose the candidate who took no position. Comparing the subject-candidates with beliefs and programmed candidates treatments, the marginal effect of having programmed candidates is 22.2 percentage points. It is clear that the evidence of cursed behavior is not driven by Bayesian voters believing that subject-candidates make mistakes.

Response error

One possible explanation for the fact that voters chose the candidate who took no position some fraction of the time could be that some subjects were simply

answering randomly. Data from choices that should have been trivial can be used to get an idea of the extent to which this could explain these choices. When both candidates committed, but one candidate committed to a policy that was better for the voter, monotonicity alone implies that the voter should choose the candidate who committed to the policy that would give her a larger payoff. The results of analysis of these choices can be found in Appendix table B.2. The dependent variable is equal to one if the voter chose the candidate whose election guarantees her a lower payoff and zero otherwise. As in column 2 of the previous table, the dependent variable is regressed on a Candidate 1 dummy and dummies for each treatment-condition cell.

When one candidate committed to the voters' favorite policy, it was very unlikely that voters would choose the other candidate, though there were a few mistakes. It is plausible that response error could generate the pattern of voting for a candidate who took no position over one who committed to B/D. If one assumes that subjects are more likely to make errors when the utility cost of making the error is small, then one would expect more errors in conditions in which the expected payoff from electing a candidate who took no position is closer to 4. This implies that Bayesians who respond with error would occasionally vote for a candidate who took no position in the low-noise skewed condition, more often in the low-noise uniform condition, and still more often in the high-noise uniform condition. One could imagine estimating the degree of response error in choices with the potential for monotonicity violations and using this to construct the probability of voting for a candidate who took no position under the assumption that voters are Bayesians who respond with error. However, it seems quite possible that subjects would take more care to avoid response error if they expected the election to be close, but cared less about making errors when they did not expect their vote to be pivotal. If a subject expected that enough other participants would make the correct choice, she could respond randomly in these choices and only focus on decisions in which her vote would be more likely to determine the outcome. When facing a choice between a candidate who committed to B/D and one who took no position, subjects may expect that

they may disagree with other subjects about the identity of the best candidate, since voters' risk aversion and beliefs may differ. Thus, voters may be inclined to take more care with this decision than with the trivial ones. For this reason, using data on trivial choices to estimate the response error in more meaningful choices would generate misleading conclusions.

Moreover, a small number of subjects were responsible for a large number of violations of monotonicity. At the other end, 75 subjects never violated monotonicity, and 21 subjects only violated it once. Among these subjects, response error seems to be extremely low. Appendix table B.3 repeats the main analysis with the sample restricted to subjects who violated monotonicity at most once. The main results continue to hold, though the loss of power makes it difficult to find statistically significant differences across conditions within a treatment.

2.5.2 Individual behavior

Categorization of voting behavior

To confirm the results of the aggregate analysis, one can look at individual behavior. For each condition, each subject is classified as showing a preference for the candidate who committed to B/D, a preference for the candidate who took no position, or indifference. Each subject made up to 10 choices between this pair of candidate platforms within each condition.⁸ The fraction of votes cast for each candidate is calculated by adding the votes cast, giving half a vote to each candidate if the subject actively chose to abstain. If the subject cast at least 60 percent of her votes for a candidate in a condition, she is classified as supporting that candidate in that condition. If each candidate receives between

8

In treatments with subject-candidates, a subject would not have made all 10 choices if she had been chosen to be a candidate for one or more periods during that condition. Subjects would also have made fewer than 10 choices if they were in a session that had fewer periods in that condition due to time constraints.

40 and 60 percent of the votes, the subject is classified as being indifferent.⁹

Table 2.5: Individual Voter Choices Between A Candidate Who Took No Position and A Candidate Who Committed to B/D

Vote Pattern			Subject- Candidates, No Beliefs	Subject-, Candidates With Beliefs	Programmed Candidates, With Beliefs	Cumulative Probability
LS	LU	HU				
B/D or -	B/D	B/D	24	38	25	66.4
B/D or -	B/D	~	1	2	1	69.5
B/D or -	B/D	n.p.	4	5	3	78.6
B/D	~	n.p.	0	1	1	80.2
B/D	n.p.	n.p.	0	0	4	83.2
~	n.p.	n.p.	1	0	1	84.7
-	n.p.	n.p.	5	0	0	88.6
n.p.	n.p.	n.p.	0	2	13	100
Not categorized			1	7	8	

Notes: ~indicates that the subject was indifferent. n.p stands for "no position." LS, LU, and HU denote the low-noise skewed, low-noise uniform, and high-noise uniform conditions, respectively. Within each condition, a subject is said to vote for a candidate if she cast at least 60 percent of her votes during those periods for that candidate. Subjects who made choices in the binary risky decision task consistent with a coefficient of absolute risk aversion $\alpha \geq 0.305$ are classified as too risk-averse and not included here. "-" indicates missing data for that condition due to the programming error.

Table 2.5 shows the transitions that individual voters make as they move through different conditions. This table does not include very risk-averse subjects, since their voting for the candidate who committed to B/D in each condition is not informative regarding their degree of cursedness. 59 percent of

⁹

Changing the vote threshold to 70 percent does not affect the pattern. Appendix table B.4 presents results using this threshold.

subjects made choices consistent with Bayesian updating, or with a very low level of cursedness. At the other end of the spectrum, 10 percent of subjects supported the candidate who took no position across all conditions, consistent with χ above 0.75. Most of these subjects were in the treatment with programmed candidates. Aside from the 11 percent of subjects who made choices that were not consistent with the model (being indifferent in more than one condition, or being more likely to vote for a candidate who took no position in the low-noise skewed condition), the remaining subjects made choices consistent with partial cursedness. Many of these subjects supported the candidate who took no position only in the high-noise uniform condition, which is consistent with $0.19 \leq \chi \leq 0.46$. While the aggregate results could also have been consistent with all subjects slightly increasing the probability of voting for the candidate who took no position across conditions, the individual-level analysis lends credence to the interpretation that the changes were driven by individuals making significant changes in their behavior when the condition changed.

Structural analysis

The results described above provide reduced-form evidence in support of a model that incorporates partial cursedness. In this section, choices between a candidate who committed to B/D and a candidate who took no position, in combination with choices made in the risky decision task, are used to identify χ . Let x_{it} be equal to one if subject i voted for the candidate who took no position in choice t and equal to 0 if subject i voted for the candidate who committed to B/D. Choices to abstain are dropped from the analysis; this affects very few observations. If a subject always voted for the same candidate within each condition, then his behavior is consistent with the model without response error. Bounds on his cursedness parameter can be constructed directly using the equations derived in the Appendix to the theory chapter, by assuming either that the near-revelation or ambiguity equilibrium is played. α_i comes from the choices made in the risky decision task, as described above. Since the risky decision task allows for inference of bounds on the risk aversion parameter, bounds for

the cursedness parameter are constructed using each bound on the risk aversion parameter. Subjects for whom this coefficient could not be estimated are not included in this exercise.

Because this task also gives only bounds on the risk aversion parameter, one can provide a range of possible values for χ_i , corresponding to different assumptions that may be made. For example, suppose that a subject never votes for a candidate who takes no position when the opponent committed to B/D. The lower bound on χ must be zero; these voting choices are consistent with being Bayesian. The upper bound is the threshold that would make the subject indifferent between the candidates. As shown in the theory chapter, the threshold is higher for any given parameter values for the ambiguity equilibrium than the near-revelation equilibrium. In addition, the threshold is higher when the subject is more risk-averse. Therefore, the upper bound is the value of χ calculated assuming that the ambiguity equilibrium is being played and using the upper bound on the subject's coefficient of absolute risk aversion.

The behavior of most of the subjects who change behavior within a condition can be modeled using a standard discrete choice model that allows for response error. Subject i 's utility from voting for the candidate who took no position is $\tilde{\pi}_{A|n}u_i(2) + (1 - \tilde{\pi}_{A|n} - \tilde{\pi}_{C|n})u_i(4) + \tilde{\pi}_{C|n}u_i(10)$. her utility from voting for the candidate who committed to B/D is $u_i(4)$. Under the assumption that response errors are independent and follow the extreme value distribution, the probability that subject i votes for the candidate who took no position is

$$= \frac{\frac{\exp(\tilde{\pi}_{A|n}(u_i(2) - u_i(4)) + u_i(4) + \tilde{\pi}_{C|n}(u_i(10) - u_i(4)))}{\exp(\tilde{\pi}_{A|n}(u_i(2) - u_i(4)) + u_i(4) + \tilde{\pi}_{C|n}(u_i(10) - u_i(4))) + \exp(u_i(4))}}{1 + \exp(\tilde{\pi}_{A|n}(u_i(4) - u_i(2)) - \tilde{\pi}_{C|n}(u_i(10) - u_i(4)))}$$

Suppose first that the near-revelation equilibrium is being played. The beliefs about a candidate who took no position, as a function of χ , are $\tilde{\pi}_{A|n} = \frac{\pi_A[1-\chi\gamma(1-\pi_A)]}{1-\gamma(1-\pi_A)}$ and $\tilde{\pi}_{C|n} = \frac{\pi_C[1-\gamma(1-\chi\pi_A)]}{1-\gamma(1-\pi_A)}$. Given these beliefs, the probability of voting

for a candidate who took no position is

$$\frac{1}{1 + \exp\left(\frac{\pi_A[1-\chi\gamma(1-\pi_A)]}{1-\gamma(1-\pi_A)}(u_i(4) - u_i(2)) - \frac{\pi_C[1-\gamma(1-\chi\pi_A)]}{1-\gamma(1-\pi_A)}(u_i(10) - u_i(4))\right)}$$

Let T_i denote the number of choices made by subject i . The likelihood of observing the choices made by subject i is

$$L_i = \prod_{t=1}^{T_i} \left(\frac{1}{1 + \exp\left(\frac{\pi_A[1-\chi\gamma(1-\pi_A)]}{1-\gamma(1-\pi_A)}(u_i(4) - u_i(2)) - \frac{\pi_C[1-\gamma(1-\chi\pi_A)]}{1-\gamma(1-\pi_A)}(u_i(10) - u_i(4))\right)} \right)^{x_{it}} \\ * \left(\frac{1}{1 + \exp\left(\frac{\pi_C[1-\gamma(1-\chi\pi_A)]}{1-\gamma(1-\pi_A)}(u_i(10) - u_i(4)) - \frac{\pi_A[1-\chi\gamma(1-\pi_A)]}{1-\gamma(1-\pi_A)}(u_i(4) - u_i(2))\right)} \right)^{1-x_{it}}$$

The log likelihood function is then

$$\ln(L_i) = \sum_{t=1}^{T_i} -x_{it} \ln\left[1 + \exp\left(\frac{\pi_A[1-\chi\gamma(1-\pi_A)]}{1-\gamma(1-\pi_A)}(u_i(4) - u_i(2)) - \frac{\pi_C[1-\gamma(1-\chi\pi_A)]}{1-\gamma(1-\pi_A)}(u_i(10) - u_i(4))\right)\right] \\ - (1 - x_{it}) \ln\left[1 + \exp\left(\frac{\pi_C[1-\gamma(1-\chi\pi_A)]}{1-\gamma(1-\pi_A)}(u_i(10) - u_i(4)) - \frac{\pi_A[1-\chi\gamma(1-\pi_A)]}{1-\gamma(1-\pi_A)}(u_i(4) - u_i(2))\right)\right]$$

Each subject's χ_i is estimated using maximum likelihood, by running the model for each subject's choices separately. As with subjects who were consistent within each condition, the model is estimated separately using the lower and upper bounds on the subject's risk aversion paramter. Analogous models are estimated under the assumption that candidates are playing the ambiguity equilibrium. In addition to the 45 subjects who were dropped because of a missing risk aversion parameter, two risk-loving subjects have only a maximum α and eight very risk-averse subjects have only a minimum α . There were also

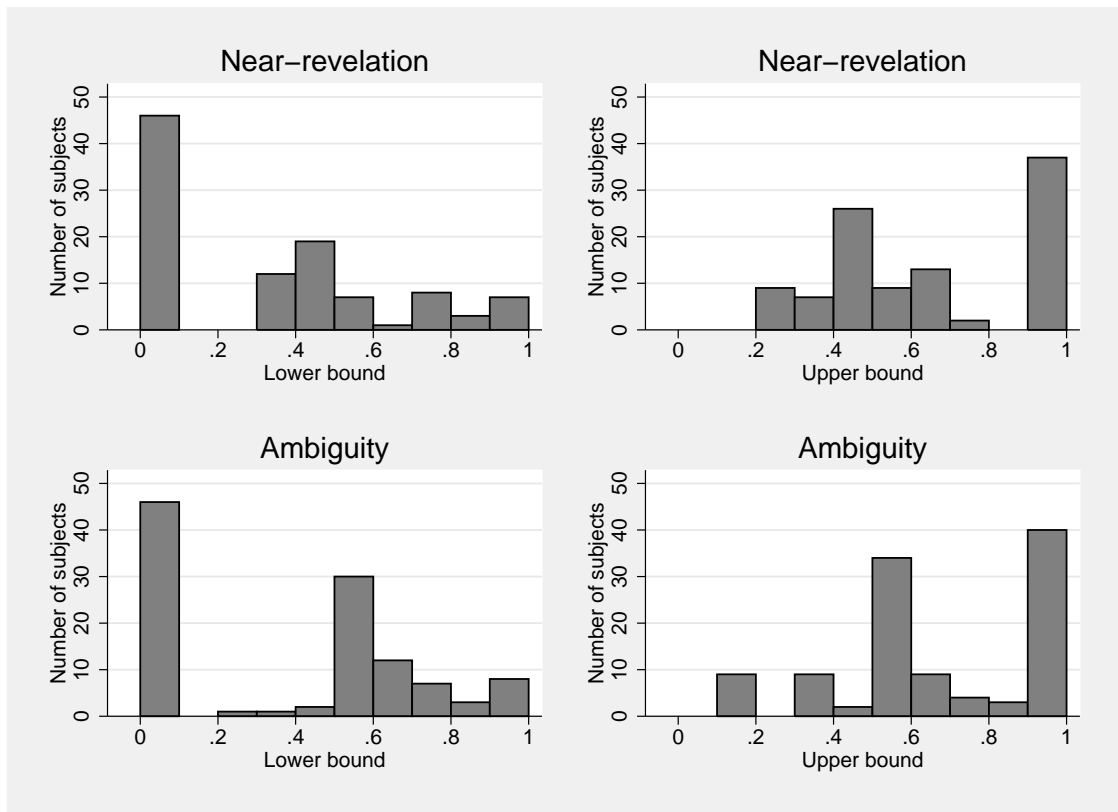
several subjects for whom the model could not be fit with one or both of their α bounds: this occurred for both equilibrium assumptions for nine subjects, for the near-revelation equilibrium only for seven subjects, and for the ambiguity equilibrium for one subject. In these cases, the subjects made inconsistent choices across and within conditions, such that the likelihood functions were not well-behaved.

Averaging across subjects for whom at least one bound could be constructed¹⁰, the mean lower and upper bounds of χ assuming the near-revelation equilibrium are 0.32 and 0.66, respectively. Assuming the ambiguity equilibrium, the mean lower and upper bounds are 0.38 and 0.69, respectively. Note that the lower bounds use the lower bound for χ constructed using the lower bound on the risk aversion parameter, and the upper bounds use the upper bound for χ constructed using the upper bound on the risk aversion parameter. Given the heterogeneity observed in the experiment, it is appropriate to look at the entire distribution, rather than just the means. Figure 2.2 shows the estimated distributions of the lower and upper bounds of χ , under each equilibrium assumption.

¹⁰

If maximum likelihood failed for a subject, the bound was not constructed, rather than set to zero or one

Figure 2.2: Distributions of Cursedness Parameter



Notes: This figure shows upper and lower bounds of the cursedness parameter, constructed as described in the text. Subjects for whom the risk aversion parameter could not be estimated are excluded. A bound is also missing if the maximum likelihood estimation failed for that subject due to inconsistent choices between candidates across conditions.

2.5.3 Extreme avoidance of candidates who take no position

Voters' behavior

Interestingly, a significant share of voters did not choose the candidate who took no position when the other candidate committed to the worst possible policy from the voters' point of view. Pooling across all treatments and conditions, subjects voted for the candidate who took no position only 67.9 percent of the time, voted for the candidate who committed to A/E 27.5 percent of the time, and abstained 4.7 percent of the time. Results from models that use a dummy for whether the voter abstained or voted for the candidate who committed to A/E when the opponent took no position as the dependent variable can be found in table 2.6. While the share of votes for the candidate who committed to A/E should have been close to zero, it ranged from 24.4 percent in the high-noise uniform condition in the treatment with programmed candidates to 46.9 percent in the low-noise skewed condition in the treatment with subject-candidates and no belief questions. The vote share was 8.0 percentage points higher in the low-noise skewed condition than in the low-noise uniform condition ($p=0.005$), while there was no statistically significant difference between the low-noise uniform and high-noise uniform conditions. There were no statistically significant differences between treatments, though subjects in the programmed candidates treatment did vote for the candidate who committed to A/E less often. The control for subjects who were too risk-averse is included in columns 3 and 4; however, its coefficient is not statistically significant.

Effect on main results

Discussion of possible explanations for this result is deferred until section 2.6. Regardless of the reason why voters behaved this way, it is important to account for it when interpreting the main results. It is likely that a voter who

Table 2.6: Proportion of Votes That Were For A Candidate Who Committed To A/E Over A Candidate Who Took No Position

		(1)	(2)	(3)	(4)
Subject Candidates, No Beliefs	Low-Noise Skewed	0.469*** (0.094)	0.479*** (0.094)	0.529*** (0.100)	0.539*** (0.100)
	Low-Noise Uniform	0.394*** (0.070)	0.404*** (0.071)	0.417*** (0.076)	0.428*** (0.076)
	High-Noise Uniform	0.345*** (0.067)	0.356*** (0.067)	0.360*** (0.073)	0.370*** (0.073)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.414*** (0.072)	0.425*** (0.072)	0.432*** (0.075)	0.443*** (0.075)
	Low-Noise Uniform	0.311*** (0.058)	0.321*** (0.058)	0.329*** (0.061)	0.340*** (0.061)
	High-Noise Uniform	0.296*** (0.059)	0.306*** (0.060)	0.315*** (0.062)	0.325*** (0.063)
Programmed Candidates, With Beliefs	Low-Noise Skewed	0.317*** (0.056)	0.327*** (0.056)	0.315*** (0.058)	0.326*** (0.059)
	Low-Noise Uniform	0.253*** (0.055)	0.263*** (0.056)	0.251*** (0.056)	0.262*** (0.057)
	High-Noise Uniform	0.244*** (0.049)	0.254*** (0.050)	0.246*** (0.051)	0.257*** (0.052)
Candidate 1			-0.021* (0.011)		-0.022* (0.011)
R-Squared		0.33	0.33	0.35	0.35
N		3494	3494	3222	3222
(# of subjects)		(160)	(160)	(147)	(147)
Marginal Effects					
Subject Candidates, No Beliefs		0.063 (0.089)	0.063 (0.089)	0.075 (0.095)	0.075 (0.095)
Programmed Candidates, With Beliefs		-0.067 (0.074)	-0.067 (0.074)	-0.086 (0.077)	-0.086 (0.077)
Low-Noise Skewed		0.080*** (0.028)	0.080*** (0.028)	0.088*** (0.029)	0.088*** (0.029)
High-Noise Uniform		-0.020 (0.021)	-0.020 (0.021)	-0.020 (0.022)	-0.020 (0.022)

Notes: The dependent variable is a dummy for voting for the candidate committed to A/E or abstaining when the opponent took no position. Models estimated using OLS. Subjects who made choices in the binary risky decision task consistent with $\alpha \geq 0.305$ are excluded from the sample in models 3 and 4. Standard errors clustered at the subject level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. The only significant difference between conditions was between the low-noise skewed and low-noise uniform conditions in the subject-candidates with beliefs treatment ($p \leq 0.05$) and programmed candidates treatment ($p < 0.10$). There were no significant differences between treatments within a condition. Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, With Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform."

would not vote for a candidate who took no position over a candidate who committed to A/E would also not vote for the candidate who took no position if the opponent committed to B/D, regardless of the degree of cursedness. To address this, one can add a control for whether the voter did not vote for the candidate who took no position when the opponent committed to A/E. Results are reported in table 2.7. Column 1 repeats the baseline specification in column 1 of table 2.4. In column 2, the model includes the control for voting for the candidate who committed to A/E interacted with treatment dummies. Compared to other voters, those who supported the candidate who committed to A/E were 19, 6 (not statistically significant), and 28 percentage points less likely to vote for a candidate who took no position when the opponent committed to B/D in the no beliefs treatment, treatment with subject-candidates with beliefs, and programmed candidates treatment, respectively. Coefficients on treatment-condition dummies, which are vote shares adjusted to take account if this behavior, increased by 0.02-0.09 when this control was added to the baseline specification shown in column 1. Column 3 estimates the same model as column 2, excluding too risk-averse subjects from the sample. The effect of voting for A/E is similar, though it is now marginally significant in the subject-candidates with beliefs treatment.

Table 2.7: Proportion of Votes That Were For A Candidate Who Took No Position Over A Candidate Who Committed To B/D: Control For Voting for A/E Over No Position

		(1)	(2)	(3)
Subject Candidates, No Beliefs	Low-Noise Skewed	0.086*** (0.033)	0.177*** (0.062)	0.220*** (0.074)
	Low-Noise Uniform	0.185*** (0.057)	0.261*** (0.073)	0.296*** (0.085)
	High-Noise Uniform	0.252*** (0.062)	0.318*** (0.076)	0.362*** (0.086)
	Voted for A/E vs No Position		-0.192*** (0.071)	-0.227*** (0.081)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.121*** (0.043)	0.147*** (0.044)	0.146*** (0.047)
	Low-Noise Uniform	0.101*** (0.025)	0.121*** (0.026)	0.123*** (0.027)
	High-Noise Uniform	0.193*** (0.040)	0.211*** (0.041)	0.199*** (0.040)
	Voted for A/E vs No Position		-0.062 (0.045)	-0.058 (0.045)

Table 2.7 – continued from previous page

Programmed Candidates, With Beliefs	Low-Noise Skewed	0.340*** (0.053)	0.430*** (0.067)	0.455*** (0.069)
	Low-Noise Uniform	0.335*** (0.057)	0.407*** (0.068)	0.431*** (0.072)
	High-Noise Uniform	0.405*** (0.056)	0.474*** (0.066)	0.509*** (0.068)
	Voted for A/E vs No Position		-0.282*** (0.071)	-0.301*** (0.075)
R-Squared		0.29	0.33	0.35
N		3494	3494	3222
(# of subjects)		(160)	(160)	(147)
Marginal Effects				
		(1)	(2)	(3)
Subject Candidates, No Beliefs		0.042 (0.054)	0.056 (0.056)	0.086 (0.062)
Programmed Candidates, With Beliefs		0.222*** (0.056)	0.206*** (0.053)	0.228*** (0.054)
Low-Noise Skewed		-0.014 (0.026)	-0.001 (0.025)	0.002 (0.027)
High-Noise Uniform		0.077*** (0.023)	0.073*** (0.021)	0.075*** (0.022)

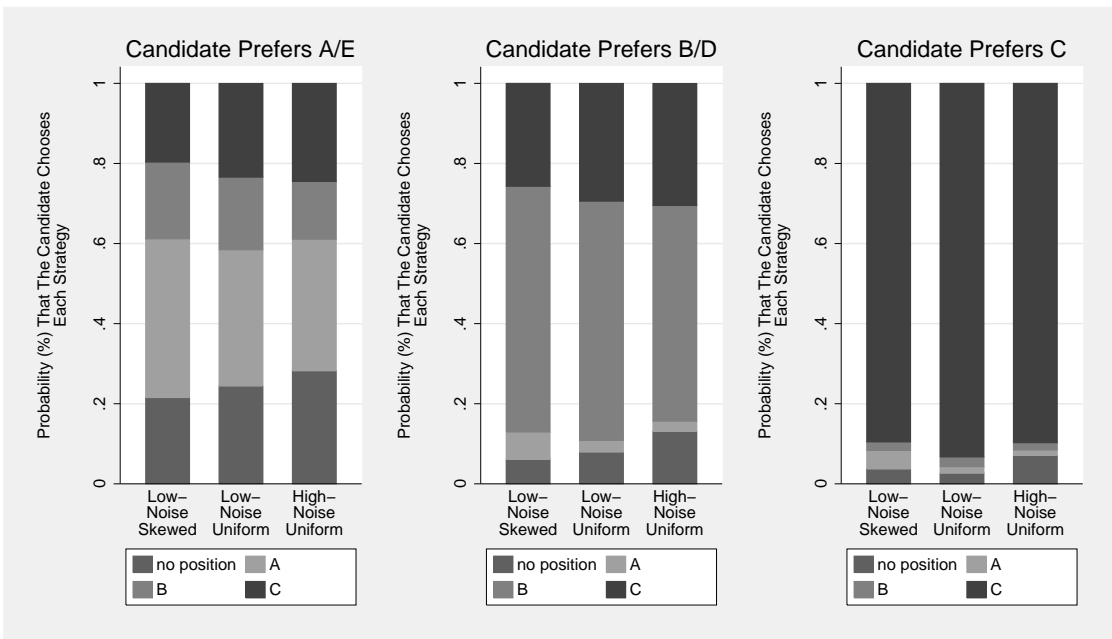
Notes: The dependent variable is a dummy for voting for the candidate who took no position when the opponent committed to B/D. Models estimated using OLS. Standard errors clustered at the subject level. Models estimated using OLS. Subjects who made choices in the binary risky decision task consistent with $\alpha \geq 0.305$ are excluded from the sample in model 3. "Voted for A/E" is a dummy variable equal to one if the voter abstained or chose the candidate who committed to A/E over the candidate who took no position and 0 otherwise. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. Differences between LS and LU in the no beliefs treatment are significant in (1) ($p < 0.03$) and (2) ($p < 0.07$). Differences between LU and HU are significant in the subject-candidates with beliefs treatment ($p < 0.05$) and programmed candidates treatment ($p < 0.06$ in 1, $p < 0.03$ in 2-3). In all specifications, the two treatments with beliefs are statistically different within each condition ($p < 0.01$). The treatments with subject-candidates are marginally different in LU in models 2-3 ($p < 0.08, p < 0.06$) and in HU in model 3 ($p < 0.09$). Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, No Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform."

2.5.4 Using belief data

Evidence from stated beliefs

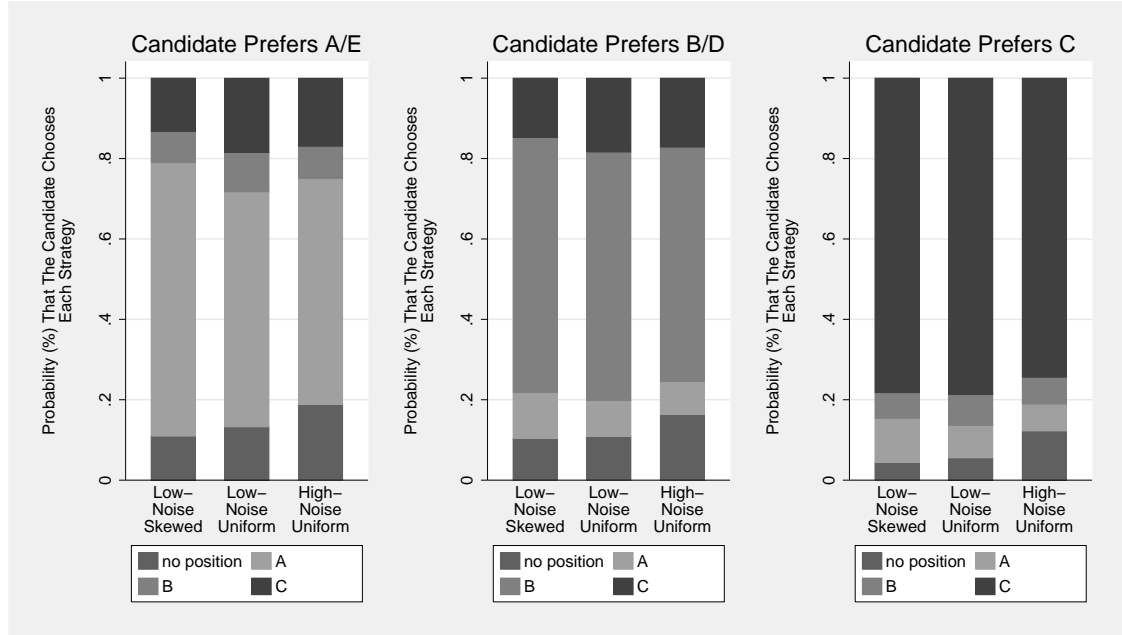
Subjects' stated beliefs provide further evidence on the subjects' understanding of the candidates' incentives. Figures 2.3 and 2.4 contain graphical representations of the average reported beliefs about candidates' strategies in the subject-candidates and programmed candidates treatments, respectively. The figures use coefficient estimates from regressions of the reported probability that a candidate of a given type chooses a given campaign strategy on treatment-condition dummies. The results of this analysis can be found in Appendix tables B.5-B.7.

Figure 2.3: Mean Beliefs About Subject-Candidates' Strategies



Notes: This figure and figure 2.4 correspond to Appendix tables B.5-B.7. The coefficients from those regressions are average reported beliefs about candidate strategies, within treatment-condition cells.

Figure 2.4: Mean Beliefs About Programmed Candidate Strategies



Voters clearly did not expect that extreme candidates would take no position in order to conceal their policy positions. Pooling across conditions, voters in the treatment with subject-candidates believed that these candidates would take no position with only 25.1 percent probability. It is possible that voters believed that the equilibrium of the game would involve these candidates committing to a policy that was more moderate than their preferred policy in order to try to win the election. This may explain why voters believed that these candidates would commit to policy C 23.0 percent of the time and commit to policy B/D 17.0 percent of the time. However, voters believed that extreme candidates were most likely to commit to the extreme policies (34.9 percent). Beliefs about programmed candidates followed a similar pattern, though voters were even more likely to believe that an extreme candidate would commit to A/E (60.7 percent) and less likely to commit to policy C (16.1 percent) or policy B/D (8.6 percent) than subject-candidates. Voters believed that extreme candidates were more likely to commit to A/E and less likely to commit to C in the low-noise skewed

condition than in the low-noise uniform condition. They also believed that candidates were less likely to commit to B/D and more likely to take no position in the high-noise uniform condition than in the low-noise uniform condition.

Next, consider beliefs about candidates who prefer B/D. While the average probability that such candidates commit to A/E is positive, it is not very large, at only 3.7 percent in the subject-candidates treatment and 9.4 percent in the programmed candidates treatment. Subjects believed that these candidates were most likely to commit to their preferred policies, with probability 57.9 percent with subject candidates and 61.3 percent with programmed candidates. They believed that it was also fairly likely that these candidates would go to the center and commit to policy C, 28.9 percent of the time for subject-candidates, though just 16.8 percent of the time for programmed candidates. While voters did not believe that extreme candidates were very likely to take no position to begin with, they believed that candidates who preferred B/D were about half as likely to do so. They believed that subject-candidates took no position with probability 9.5 percent and programmed candidates did so with probability 12.6 percent.

Subjects clearly understood that candidates who agreed with the voters should commit to their common preferred policy. Subjects believed that subject-candidates did so 91.0 percent of the time, while committing to A/E 2.3 percent of the time, committing to B/D 2.1 percent of the time, and taking no position 4.6 percent of the time. Again, there appeared to be more confusion or response error in the programmed candidates treatment. There, only 77.0 percent probability was put on committing to C, while subjects believed that these candidates would commit to A/E with 8.5 percent probability, commit to B/D with 7.0 percent probability, and take no position with 7.5 percent probability.

It turns out that subjects' beliefs were actually fairly well-calibrated when compared to subject-candidates' behavior. In the middle panel of Appendix tables B.5-B.7, the true choice probabilities are given for comparison. Since these choices are not statistically different between treatments that include be-

lief questions and those that do not, both treatments with subject-candidates are pooled.¹¹ Given the behavior of extreme candidates, subjects' beliefs were actually fairly close. In fact, these candidates actually chose to commit to policy A/E even more often than the subjects predicted, 40.0 percent of the time. These candidates also tried committing to more moderate positions, though they were more likely to commit to B/D (35.8 percent) than to go all the way to C (11.6 percent). Voters also correctly believed that these candidates were reluctant to choose to take no position, doing so just 12.6 percent of the time.

Voters were generally correct about candidates who preferred B/D as well, though voters' beliefs had some weight shifted from committing to B/D to committing to C, relative to what the candidates actually did. These candidates were most likely to commit to B/D (70.7 percent), though they did commit to C 25.3 percent of the time. They chose to take no position with probability 4.0 percent, slightly less often than voters predicted. Candidates who preferred C chose to commit to C 96.2 percent of the time, indicating that while there were a few mistakes, they understood their role as well as voters thought they did.

Voting behavior conditional on beliefs about candidates

Since subjects believed that all types of candidates were not likely to choose to take no position, the posterior probability that a candidate has a given preferred policy conditional on having taken no position does not vary much across preferred policies. This is shown graphically in figure 2.5. This presents the average probabilities that subjects put on a candidate who took no position having each preferred policy.¹²

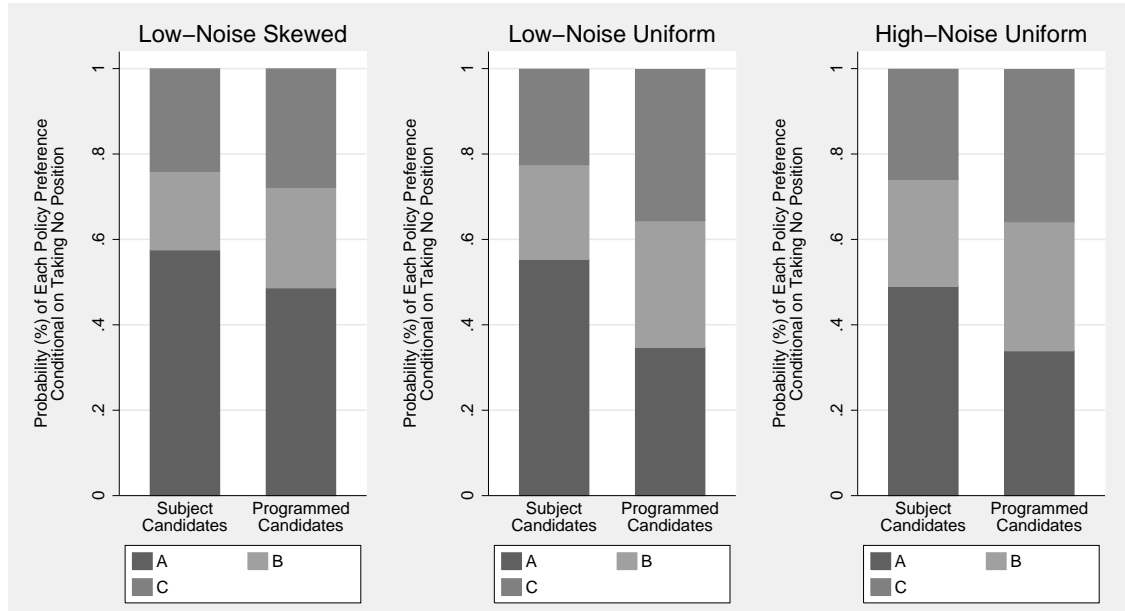
¹¹

The full results about candidates can be found in Appendix table B.8 if the reader is interested. However, this paper focuses on voters, and the experiment was not designed to have sufficient power to analyze the candidates' behavior.

¹²

Analysis of this belief data, using the probability that a candidate who took no position has a given preferred policy as the dependent variable and regressing it on treatment-condition cells, can be found in Appendix table B.9

Figure 2.5: Mean Beliefs About the Preferred Policy of a Candidate Who Took No Position



Notes: This figure corresponds to Appendix table B.9. The coefficients from those regressions are average reported beliefs about the preferred policy of a candidate who took no position, within treatment-condition cells.

The expected value of a candidate who took no position is a useful measure, because it combines the answers to several questions about beliefs and is relevant to the choices between such a candidate and one who committed to B/D. Table 2.8 shows the average expected value of a candidate who took no position, by treatment-condition, estimated by regressing the expected value on treatment-condition dummies. It is calculated in one column using the beliefs about strategies and in the other using the reported posterior beliefs. The expected value consistent with several benchmarks (beliefs of a fully cursed subject, beliefs consistent with the near-revelation equilibrium being played, and the empirical expected value based on candidate behavior) are also presented for comparison. The expected values derived from beliefs were close to the fully cursed benchmark; however, this is also consistent with believing that all can-

didates commit.

This potentially creates a problem. If a voter believed that all candidates were equally likely to take no position because she believed that all candidates would choose to commit, then she would choose to vote for a candidate who took no position (assuming she is not too risk-averse). Her behavior could not be distinguished from the behavior of a cursed voter. To address this possible issue, belief data was used to classify subject-period observations by the belief about the equilibrium being played. The possible categorizations were: belief that at least one type of a candidate would choose to take no position, belief that all types would commit to either policy B/D or C, and belief that all candidates would commit, with candidates who prefer A/E committing to A/E. Table 2.9 lists the percentage of subject-period observations in each belief category, broken down by treatment and condition. While most subjects believed that the candidates were playing an equilibrium that involved all types committing, there remains a substantial fraction who believed that candidates might choose to take no position.

In table 2.10, the regression models include controls for belief in an equilibrium that involves all candidates making commitments. Once this is taken into account, expected values are much lower, though still higher than those consistent with Bayesian updating in the near-revelation equilibrium. There is also a difference between the expected value constructed using reported posteriors and that constructed using beliefs about strategies; the differences between conditions are smaller with reported posteriors. This implies that base rate neglect is affecting subjects' ability to move from beliefs about strategies to posterior beliefs to some extent. It is possible that more changes in behavior across conditions would have been observed, given subjects' beliefs about strategies, had they correctly perceived how the changes in the parameters of the game would affect the probability that a candidate who took no position had each preferred policy.

Table 2.8: Expected Value of a Candidate Who Took No Position

		(1)	(2)	(3)	(4)
		Reported Posteriors	Derived From Beliefs About Strategies	Based on Actual Behavior	Fully Cursed Voters
Subject Candidates, With Beliefs	Low-Noise	4.266	3.895	3.696	4.50
	Skewed	(0.303)	(0.116)		
	Low-Noise	4.252	4.496	4.710	5.33
	Uniform	(0.271)	(0.109)		
	High-Noise	4.570	4.874	4.996	5.33
Programmed Candidates, With Beliefs	Uniform	(0.264)	(0.072)		
	Low-Noise	4.690	4.303	2.455	4.50
	Skewed	(0.159)	(0.057)		
	Low-Noise	5.426	5.115	2.833	5.33
	Uniform	(0.206)	(0.078)		
R-Squared	High-Noise	5.457	5.198	3.667	5.33
	Uniform	(0.176)	(0.048)		
		0.88	0.98		
N		2680	2670		
		(119)	(119)		
Marginal Effects					
Programmed Candidates, With Beliefs		0.847***	0.453***		
		(0.308)	(0.105)		
Low-Noise Skewed		-0.397***	-0.716***		
		(0.115)	(0.048)		
High-Noise Uniform		0.161**	0.217***		
		(0.073)	(0.038)		

Notes: Estimates produced by regressing the expected value of a candidate who took no position on dummies for each treatment-condition cell. In column (1), expected value is constructed using the reported beliefs that a candidate who took no position has each preferred policy. In column (2), reported beliefs about the strategy that each type of candidate would choose are used to construct posterior beliefs using Bayes' Rule, and these beliefs are used to compute expected value. Standard errors clustered at the subject level. In (1), the LU and HU conditions are statistically different in the subject-candidates treatment ($p=0.02$) and the LS and LU conditions are statistically different in the programmed candidates treatment ($p=0.000$). In (2), the LS and LU conditions and LU and HU conditions are statistically different in the subject-candidates treatment ($p=0.000$) and the LS and LU conditions are statistically different in the programmed candidates treatment ($p=0.000$). In (1) and (2), the two treatments were statistically different within the LU and HU conditions ($p<0.01$), and in (2) they were also statistically different within the LS condition ($p=0.002$). (3) gives the expected value that voters would have had if they knew the actual average candidate choices, pooling treatments with and without belief questions. (4) gives the beliefs that fully cursed voters would have. Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, With Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform." *, **, and *** indicate that a marginal effect is statistically different from zero at the 10%, 5%, and 1% level, respectively.

Table 2.9: Belief Breakdown

		Believes a Candidate Will Take No Position	Believes All Commit to B/D or C	Believes All Commit, Some Commit to A/E	Sample Size
Subject Candidates, With Beliefs	Low-Noise	32.4	25.3	42.4	340
	Skewed	(21)	(16)	(26)	(46)
	Low-Noise	33.9	28.2	37.8	436
	Uniform	(27)	(23)	(28)	(59)
	High-Noise	33.9	29.6	36.5	436
	Uniform	(31)	(28)	(31)	(59)
Programmed Candidates, With Beliefs	Low-Noise	15.8	4.8	79.4	462
	Skewed	(15)	(6)	(54)	(60)
	Low-Noise	21.8	11.8	66.4	500
	Uniform	(21)	(12)	(46)	(60)
	High-Noise	20.8	9.7	69.6	496
	Uniform	(19)	(9)	(47)	(60)

Notes: This table gives the percentage of subject-period observations (number of subjects in parentheses) with reported beliefs in each category. The final column lists the total number of subject-period observations (total number of subjects in parentheses). The numbers of subjects may not add up to the total across a row if a subject's belief category changes during the experiment. A subject is said to believe that a candidate will play a given strategy if she reports that strategy as at least five percentage points more likely than every other strategy. If the subject puts at least 40 percent probability on each of two strategies, she is said to believe that the candidate will play both strategies. A subject is said to believe that a candidate will take no position if she believes that at least one type of candidate will choose no position, either alone or in combination with another strategy. She is said to believe that all commit to B/D or C if she believes that all types of candidate commit to B/D, commit to C, or play both of these strategies. She is said to believe that all commit, with candidates who prefer A/E committing to A/E if she believes that candidates who prefer A/E choose A/E, alone or in combination with another commitment strategy, and the other candidates choose any combination of commitment strategies. There were no subjects who believed that another type of candidate would commit to A/E if a candidate who prefers A/E would not.

Table 2.10: Expected Value of a Candidate Who Took No Position: Control for Belief in Commitment Equilibrium

		(1)	(2)	(3)	(4)
		Reported Posteriors	Derived From Beliefs About Strategies	Based on Actual Behavior	Fully Cursed Voters
Subject-Candidates, With Beliefs	Low-Noise Skewed	3.061 (0.210)	3.148 (0.115)	3.696	4.50
	Low-Noise Uniform	3.093 (0.167)	3.772 (0.119)	4.710	5.33
	High-Noise Uniform	3.417 (0.187)	4.153 (0.102)	4.996	5.33
	Commitment Belief-B/D/C	1.474*** (0.425)	0.991*** (0.144)		
	Commitment Belief-A/E	1.964*** (0.311)	1.173*** (0.117)		
	Low-Noise Skewed	3.770 (0.331)	3.681 (0.181)	2.455	4.50
	Low-Noise Uniform	4.460 (0.360)	4.544 (0.195)	2.833	5.33
	High-Noise Uniform	4.512 (0.349)	4.617 (0.177)	3.667	5.33
	Commitment Belief-B/D/C	2.484*** (0.865)	0.644*** (0.188)		
Programmed Candidates, With Beliefs	Commitment Belief-A/E	1.013*** (0.321)	0.745*** (0.184)		
	R-Squared	0.90	0.99		
	N (# of subjects)	2668 (119)	2670 (119)		
Marginal Effects					
Programmed Candidates, With Beliefs		0.713** (0.318)	0.290*** (0.070)		
Low-Noise Skewed		-0.391*** (0.105)	-0.755*** (0.038)		
High-Noise Uniform		0.176** (0.074)	0.212*** (0.039)		

Table 2.10 – continued from previous page

Notes: Estimates produced by regressing the expected value of a candidate who took no position on dummies for each treatment-condition cell. In column (1), expected value is constructed using the reported beliefs that a candidate who took no position has each preferred policy. In column (2), reported beliefs about the strategy that each type of candidate would choose are used to construct posterior beliefs using Bayes' Rule, and these beliefs are used to compute expected value. Models also include controls for having beliefs that imply that no candidate chooses to take no position in equilibrium. See the notes to table 2.9 for details on the construction of these variables. Standard errors clustered at the subject level. In (1), the LU and HU conditions are statistically different in the subject-candidates treatment ($p=0.02$), while the LS and LU conditions are statistically different in the programmed candidates treatment ($p=0.000$). The treatments are statistically different in the LS ($p=0.07$), LU ($p=0.001$) and HU ($p=0.007$) conditions. In (2), the LS and LU conditions are statistically different in both treatments ($p=0.000$), and LU and HU are statistically different in the subject-candidates treatment ($p=0.000$). The treatments are statistically different in the LS ($p=0.02$), LU ($p=0.001$), and HU ($p=0.03$) conditions. (3) gives the expected value that voters would have had if they knew the actual average candidate choices, pooling treatments with and without belief questions. (4) gives the beliefs that fully cursed voters would have. Marginal effects are relative to the omitted category. *, **, and *** indicate that a marginal effect or coefficient on a belief control variable is statistically different from zero at the 10%, 5%, and 1% level, respectively.

To confirm that the main results were driven by some subjects being cursed, rather than by some subjects believing that all candidates committed, controls for belief that an equilibrium in which all candidates commit are added to the main specification. Results of this analysis are reported in table 2.11. Adding these controls does not change the results. This may seem counterintuitive, since these subjects should have behaved differently. However, consider why subjects would have had those beliefs. The equilibrium in which all candidates commit to B/D or C does exist when candidates are sufficiently risk-averse. A voter who attributed a high degree of risk aversion to candidates is probably quite risk-averse herself, and a risk-averse subject would not choose a candidate who took no position in that situation. If a subject believed that candidates who prefer A/E commit to A/E, it is likely that she did so because she believed that a candidate who took no position would lose to a candidate who committed to A/E—otherwise, the candidate should not have committed to A/E. If a subject held this belief, it is likely that she would not herself vote for a candidate

who took no position. This reasoning is consistent with the evidence that voters who believed that an equilibrium with commitment by all candidates was being played were not more likely than other voters to support a candidate who took no position.

Table 2.11: Proportion of Votes That Were For A Candidate Who Took No Position Over A Candidate Who Committed To B/D: Control for Beliefs About Equilibrium

		(1)	(2)	(3)	(4)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.121*** (0.043)	0.151*** (0.042)	0.121*** (0.045)	0.149*** (0.043)
	Low-Noise Uniform	0.101*** (0.025)	0.131*** (0.034)	0.104*** (0.027)	0.132*** (0.038)
	High-Noise Uniform	0.193*** (0.040)	0.223*** (0.051)	0.180*** (0.039)	0.209*** (0.053)
	Believes All Commit to B/D or C		-0.056 (0.050)		-0.051 (0.055)
	Believes All Commit, A/E to A/E		-0.037 (0.047)		-0.036 (0.048)
	-----	-----	-----	-----	-----
Programmed Candidates, With Beliefs	Low-Noise Skewed	0.342*** (0.053)	0.462*** (0.111)	0.362*** (0.055)	0.476*** (0.115)
	Low-Noise Uniform	0.335*** (0.057)	0.437*** (0.108)	0.355*** (0.061)	0.452*** (0.112)
	High-Noise Uniform	0.403*** (0.056)	0.509*** (0.103)	0.432*** (0.058)	0.533*** (0.106)
	Believes All Commit to B/D or C		-0.011 (0.157)		-0.030 (0.160)
	Believes All Commit, A/E to A/E		-0.151 (0.108)		-0.142 (0.113)
	-----	-----	-----	-----	-----
R-Squared		0.31	0.32	0.33	0.34
N		2662	2662	2492	2492
(# of subjects)		(119)	(119)	(111)	(111)
Marginal Effects					
Programmed Candidates, With Beliefs		0.222*** (0.056)	0.244*** (0.059)	0.248*** (0.058)	0.266*** (0.060)
	-----	-----	-----	-----	-----
Low-Noise Skewed		0.013 (0.031)	0.023 (0.031)	0.012 (0.032)	0.021 (0.033)
	High-Noise Uniform	0.078*** (0.026)	0.081*** (0.027)	0.077*** (0.027)	0.079*** (0.027)

Table 2.11 – continued from previous page

Notes: The dependent variable is a dummy for voting for the candidate who took no position when the opponent committed to B/D. Models estimated using OLS. The sample is restricted to observations that contain non-missing belief data. Subjects who made choices in the binary risky decision task consistent with $\alpha \geq 0.305$ are excluded from the sample in models 3-4. Models 2 and 4 include controls for having beliefs that imply that no candidate chooses to take no position in equilibrium, interacted with treatment dummies. See the notes to table 2.9 for details on the construction of these variables. Standard errors clustered at the subject level. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. In models 1-2, there are differences between the LU and HU conditions in the subject-candidates treatment ($p < 0.02$) and programmed candidates treatment ($p < 0.07$) and between the two treatments in all conditions ($p \leq 0.01$). In 3-4, there are differences between the LU and HU conditions in the subject-candidates treatment ($p < 0.05$) and programmed candidates treatment ($p < 0.05$) and between the two treatments in all conditions ($p < 0.01$). Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, With Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform."

2.6 Discussion of avoidance of candidates who took no position

The discussion below is largely speculation about an unexpected result, and it should be interpreted with this caveat in mind. As will be described below, voting for a candidate who committed to A/E may be consistent with a model in which voters value character. Other alternative theories can be ruled out, leaving this as a plausible interpretation that is consistent with the data.

2.6.1 Preference for character interpretation

While other possible interpretations of the result are plausible (and discussed below), the most likely explanation seems to be that, even in this experimental setting, voters have preferences over characteristics of candidates that are not related to policy. Kartik and McAfee (2007) develop a theory in which voters

care both about policy and about whether candidates have character. In their model, character is an exogenous characteristic of candidates that is unobserved by the voters. Candidates with character commit to the policy that they believe in, while candidates without character are purely office-motivated and choose a platform to maximize the probability of being elected. A platform then becomes a signal of whether a candidate has character. This setting differs from theirs, because the candidates are policy-motivated; this complicates the incentives for candidates without character, which in turn increases the complexity of the signaling game. The possibility that candidates will not be able to commit further complicates the game.

Extending the theoretical model to include some notion of character is beyond the scope of this paper. Moreover, the experiment is not an ideal test for this type of model. Testing a model that includes character in the lab would require that electing a candidate with character have some meaning in the laboratory setting. Since the candidate elected only implements one policy, there is no sense in which it would be better for the voters if the elected candidate had character. We might still observe some of this behavior in the experiment conducted, possibly because subjects have social preferences and would like to elect a candidate with character, not because it would benefit the voter directly, but because they would like to reward another subject that they believe has character with a higher payoff. These explanations do not apply when the candidate roles are played by the computer, which is consistent with voters in the programmed candidates treatment being less likely to vote for the candidate who committed to A/E. However, subjects may still avoid programmed candidates who take no position if they bring in their intuitions and heuristics from real-world elections and do not consider how well they apply in the lab environment.

Even without solving the model, it is still possible to consider how adding character to the model might help to explain otherwise puzzling results in the experiment. Since candidates with character always commit to their preferred policy, a candidate who took no position could only have character if he had

been randomly prevented from making this commitment. On the other hand, it is possible that a candidate without character may decide to take no position. One would expect to see some candidates commit to A/E, if some subjects did experience the disutility from committing to a different policy that underlies the notion of character. This suggests that adding character to the model may rationalize the choices that we observe between a candidate who committed to A/E and one who took no position. It is also consistent with the observation that many voters believed that candidates who preferred A/E would commit to A/E and the fact that subject-candidates often did so.

One can also consider a variant of the model in which voters would prefer a candidate who is direct and transparent. They don't mind if a candidate commits to a policy that he does not favor for the sake of implementing what the voter wants. However, they do not want a candidate who will conceal information when it may benefit him to do so. In this alternative model, we may think of forthrightness as an exogenous characteristic. Forthright candidates are not required to commit to their preferred policy, but they must make a policy commitment. Candidates who are not forthright are not limited in their choice of strategies. Here, in contrast to Kartik and McAfee (2007), both types of candidates behave strategically, since forthright candidates still must choose whether to commit to their preferred policy or to commit to a more moderate policy. By thinking through how this change to the model affects the candidates' incentives, one can see that it may be possible to explain the results in this way. A forthright candidate who prefers A/E may want to make that commitment if he does not guarantee himself a loss by doing so, since voters see taking no position as a strong signal that a candidate is not forthright.

2.6.2 Alternative explanations

First, it is not simply the result of response error. Consider again the subsample of subjects who violated monotonicity at most once during the experiment. It is very unlikely that these subjects were answering randomly or did not un-

derstand the experiment, since they were able to make other choices that required understanding of the payoffs. Appendix table B.10 shows the results of regressions using as the dependent variable a binary variable equal to one if the subject abstained or voted for a candidate who committed to A/E when the opponent took no position, using only data from this subsample. Averaging across all treatments and conditions, these subjects voted for the candidate who took no position 82.2 percent of the time, voted for the candidate who committed to A/E 14.0 percent of the time, and abstained 3.8 percent of the time. The vote share for candidates who committed to A/E among these subjects is half of what it was in the full sample, implying that subjects who responded with error or did not understand the experiment were responsible for most of these choices (though that does not necessarily mean that these particular choices were mistakes). However, the voters who made only one or zero mistakes when comparing other pairs of candidates still opted not to vote for the candidate who took no position when the opponent committed to A/E nearly one-fifth of the time, suggesting that this result is more than just response error.

Readers who are familiar with the experimental literature on choice under risk may be aware that there has been some experimental work that shows that people sometimes do value lotteries less than they value its worst possible outcome (e.g., Gneezy, List, and Wu 2006; Van Dijk and Zeelenberg 2003). However, this work has exclusively used between-subject designs. Subjects were asked to make some choice in which one alternative was either one certain outcome, another lower certain outcome, or a lottery over these two outcomes; each subject made just one of these three choices. When choices were compared across the three groups, the percentage of people who chose the lower certain outcome was higher than the percentage of people who chose the lottery over that outcome and a higher outcome. Though, Gneezy, List and Wu report that "the internality axiom is so transparent and compelling that we expect participants to obey internality in a within-subject test"; in one variant of the experiment in which subjects made all three choices, the result went away. In the experiment studied here, subjects are confronted with a choice between a lottery and re-

ceiving for sure the worst outcome possible in the lottery. The previous work implies that since they face the lottery and the sure option at the same time, subjects would choose the lottery. Thus, the result that voters sometimes choose the candidate who committed to A/E does not reflect a previously documented behavioral bias. Instead, there must be something particular about this environment that leads subjects to behave in this way.

Another possible explanation is that there are repeated game effects. The idea is that subjects may punish candidates who take no position by never voting for them, even if this means receiving a lower payoff this period by electing a candidate who commits to A/E. This would remove the incentive for candidates to take no position and lead them to commit to policies that the voters prefer. If the voters are sufficiently patient, they might be willing to occasionally accept low payoffs in order to receive higher payoffs in other periods. If this were the primary explanation for voters choosing the candidate who committed to A/E over a candidate who took no position, then this behavior would not be expected in the final period of the experiment, when there would no longer be any repeated game concerns. However, behavior in the final period is no different from behavior in the rest of the experiment. Appendix table B.11 shows the results of regressions that use a dummy equal to one if the voter abstained or voted for the candidate who committed to A/E when the opponent took no position as the dependent variable and include a dummy for whether the choice occurred in the last period of a session. The coefficient on this dummy was not statistically significantly different from zero. Therefore, one can conclude that repeated game effects are not responsible for candidates who committed to A/E receiving votes.

2.7 Conclusion

The experimental evidence shows that while many people do behave in a way consistent with partial or full cursedness, approximately three-fourths of sub-

jects are able to understand the strategic incentives well enough to vote for the right candidate. If one believes that a sample of students at an Ivy League university is representative of the electorate in terms of ability to understand strategic incentives, this implies that cursed behavior alone cannot be an explanation for ambiguity in elections, because a candidate who attempts to take advantage of voters who do not understand the incentives will not succeed in winning the election. However, it is quite possible that the majority of Americans resemble those subjects who were unable to understand the informational content of a refusal to make a policy commitment. This experiment demonstrated the existence of cursed behavior in this important setting. If one thinks that the extent of this behavior observed with these students is a lower bound on the amount of this behavior that one would expect to see in the general population, then additional research would need to be done, on a representative sample of adults, to determine whether this phenomenon could affect elections.

Further, apparent preference for character also reduces the potential benefit of strategically not revealing a policy preference. Additional experiments should be done to verify that this finding is robust, with careful attention paid to whether subjects understand the game. Future theoretical work that allows signaling on more than one dimension of type should formally analyze the effects of these preferences, defined either as a preference for candidates who always carry out their preferred policies or as a preference for candidates who are forthright about their policy intentions, on electoral outcomes. The results of this experiment also suggest that such models can even be tested in a laboratory setting, though additional work should be done to make this non-policy factor relevant.

CHAPTER 3

BEYOND HAPPINESS AND SATISFACTION: TOWARD WELL-BEING INDICES BASED ON STATED PREFERENCE

The cornerstone of neoclassical welfare economics is the principle of revealed preference, according to which the ultimate criterion for judging what makes a person better off is what she chooses, in a situation in which she is well-informed about the consequences of her options. Yet for most policy decisions, a government cannot directly infer an individual's welfare from her choices over policies because individuals rarely make such choices.¹ Hence in practice economists often rely on revealed preference indirectly, evaluating policy options by how they affect indicators—most prominently, GDP—that can be viewed as summarizing, under some assumptions, a set of generally-desired outcomes. But because GDP and other available indicators have known limitations as well-being measures, economists have been seeking additional indicators that go "beyond GDP" (for a recent survey, see Fleurbaey 2009). In this paper, we focus on developing one such indicator: an individual-level index that combines together different aspects of well-being that may be measured by survey questions.

As candidate measures of individuals' well-being, economists and psychologists have recently been investigating survey measures of "subjective well-being" (SWB); while we use this term to refer to any subjective assessment of some aspect of well-being, economists have primarily focused on questions about one's own happiness or life satisfaction. Because responses to such questions reflect a wide range of experiences, including those unrelated to market exchange (Diener and Seligman 2004; Kahneman and Krueger 2006), many researchers have advocated conducting nation-wide SWB surveys and using the responses to calculate indicators alongside GDP-like measures (e.g., Diener

¹

Holding a referendum on every issue would incur prohibitively high transaction costs. Moreover, for many issues, even a direct vote would not reveal preferences because voters lack full information about—and might systematically mispredict—the consequences of alternative policy options (see Gilbert 2006, for evidence on systematic misprediction of happiness).

2000; Diener 2006, signed by 50 researchers; Layard 2005; Stiglitz, Sen, and Fitoussi 2009).

Although these proposals are controversial among economists, policymakers have begun to embrace them. For example, starting in April 2011, the U.K. Office of National Statistics (ONS) began including the following SWB questions in its Integrated Household Survey, a survey that reaches 200,000 adults annually (ONS 2011):

Overall, how satisfied are you with your life nowadays?

Overall, how happy did you feel yesterday?

Overall, how anxious did you feel yesterday?

Overall, to what extent do you feel the things you do in your life are worthwhile?

According to Prime Minister David Cameron, "it's time we focused not just on GDP but on GWB—general wellbeing."² Other governments around the world have expressed similar intentions to field SWB surveys and use the responses to guide policy.³

Notwithstanding this recent enthusiasm, there are many open questions regarding the endeavor of tracking well-being with surveys. Among the most urgent practical questions are the following two. First, which SWB questions should governments ask? It is increasingly recognized that more than one ques-

²

"David Cameron aims to make happiness the new GDP." The Guardian, November 14, 2010. <http://www.guardian.co.uk/politics/2010/nov/14/david-cameron-wellbeing-inquiry> as accessed on May 13, 2011.

³

For example, in December 2011, the U.S. National Academy of Sciences Committee on National Statistics convened the first in a series of meetings of a "Panel on Measuring Subjective Well-Being in a Policy Relevant Framework." As part of its Better Life Initiative, the OECD has held several conferences on "Measuring Well-Being for Development and Policy Making" since May, 2011; the organization's Better Life Index website (www.oecdbetterlifeindex.org) invites visitors to rate 36 countries by interactively creating indices from 11 dimensions of well-being that include SWB. Moreover, this interest is not limited to rich, Western countries; indeed, Bhutan is considered the pioneer of Gross National Happiness, a concept conceived there in the 1970s.

tion is likely to be needed because SWB is multi-dimensional (e.g., Ryff 1989; Kahneman and Deaton 2010) and because widely-used SWB measures may not capture all factors that enter into preferences (Benjamin, Heffetz, Kimball, and Rees-Jones 2012, 2013). Current proposals for survey questions, however, rely on different experts own readings of the SWB literature rather than on a systematic method.⁴ Second, how should responses to different questions be weighted relative to each other? Current proposals are virtually silent on relative weighting (in some cases purposefully so). But in practice, due to an apparently inevitable demand for summary indicators, ad hoc weights often end up being applied implicitly by users or explicitly in published indices (Micklewright 2001).

This paper has two overarching purposes. First, we propose a framework, grounded in a preference-based theory, for conceptualizing and discussing survey-based measurement of well-being. Second, we demonstrate a disciplined approach, anchored in revealed preference—albeit based on hypothetical choices—to applying our framework to the development of well-being surveys and indices. We emphasize that relative to the many decades of theoretical and practical work that underlies the present well-developed state of measures such as GDP, efforts to construct and apply survey-based well-being indicators are still in their infancy. Hence, we view this paper as primarily methodological, proposing an agenda for a new approach, and we view our specific contributions as first steps to be improved upon by future work.

In Section 3.1, we present our theoretical framework. We assume that utility $u(\mathbf{w})$ depends on a vector \mathbf{w} of fundamental aspects of well-being, for example those that can be measured with survey questions similar to the four above. Any vector proportional to the vector of marginal utilities $D_{\mathbf{w}}u(\mathbf{w})$ can then be used as relative weights for combining the components of \mathbf{w} into an individual-level index that tracks small changes in well-being. For large changes in the aspects, the index can still be used to track changes in well-being but only provides a

4

For prominent—and conflicting—proposals to the U.K. Office of National Statistics, see Dolan, Layard, and Metcalfe (2011) and Deaton, Kahneman, Krueger, Schkade, Schwarz, and Stone (2011).

partial welfare ordering. While we do not make novel contributions regarding how to aggregate well-being indices across individuals, our framework could be used in conjunction with existing approaches to aggregation.

In Section 3.2, we describe our attempt to identify the major components of \mathbf{w} . We compile a list of 136 aspects of well-being aimed at including all the main factors that have been proposed as important components of well-being in a sample of major works in philosophy, psychology, and economics, from Maslow (1946) to Stiglitz, Sen, and Fitoussi (2009) and beyond. The list includes aspects that have been considered as fundamental, as well as broader, "combination aspects" that may single-handedly capture many fundamental aspects. While it includes SWB measures widely used by economists (e.g., happiness and life satisfaction), it also includes other items, such as goals and achievements, freedoms, engagement, morality, self-expression, relationships, and the well-being of others. While far from exhaustive, our list represents, as far as we know, the most comprehensive effort to date to construct such a compilation (cf., Alkire 2002).

Next, as described in Section 3.3, we design and conduct a survey to estimate a vector proportional to the vector of marginal utilities $D_{\mathbf{w}}u(\mathbf{w})$. We present more than 4,600 Internet survey respondents—a demographically diverse (albeit not representative) sample of the US adult population—with sets of hypothetical-choice scenarios. We first provide detailed scenario instructions and an example. Then, in each scenario we elicit respondents' stated preference between two options that differ only on how they rate on a small set of aspects. For an example, see figure 3.1. In our estimation procedures, the dependent variable is the response to the choice question above, and the independent variables are the relative ratings of the aspects (the "X"s) in the table above. Because we randomly assign which aspects vary between the options and by how much, we can identify the relative marginal utility of each aspect. We call this stated-preference survey for estimating relative marginal utilities a *SP survey* to distinguish it from a *SWB survey* that would measure individuals' *levels* of aspects of well-being.⁵

5

Figure 3.1: Sample Scenario

Imagine you are **making a personal decision**, and that you face a choice between two options: Option 1 and Option 2. The two options are predicted to have different effects over the next four years but to have the same effects after that. The table below lists these predicted differences in the next four years. Please assume that anything not listed in the table would be marked "about equal" if it were listed.

[Click here to see the instructions again](#)

	OPTION 1					OPTION 2		
	much higher	somewhat higher	slightly higher	about equal		slightly higher	somewhat higher	much higher
how happy you feel							X	
you not feeling anxious			X					

Between these two options, which do you think you would choose?

OPTION 1			OPTION 2		
Much prefer Option 1	Somewhat prefer Option1	Slightly prefer Option 1	Slightly prefer Option 2	Somewhat prefer Option 2	Much prefer Option 2
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

We highlight differences between our specific SP-survey implementation and the theoretical ideal that we anticipate governments could approximate more closely.

Section 3.4 presents our main survey findings. Using personal-choice scenarios similar to the one above and pooling across all of our respondents we find, among other things, that while commonly-measured aspects of well-being such as happiness, life satisfaction, and health are indeed among those with the largest relative marginal utilities, other aspects that are measured less commonly have relative marginal utilities that are at least as large. These include

Broadly speaking, our SP survey can be viewed as an application of conjoint analysis (Green and Rao 1971). In the context of assessing welfare, our survey design is closely related to the method proposed in Adler and Dolan (2008), who argue that policymakers' weighting of different aspects of well-being should be informed by how survey respondents rank alternative "lives" that vary in the aspects. They illustrate their method with an exploratory study of 72 undergraduate respondents and four aspects: income, health, happiness, and life expectancy. Relatedly, Adler (2013) proposes a conceptual framework similar to ours, viewing w as a hybrid of "mental" (e.g., emotions) and "non-mental" (e.g., freedoms) aspects. He encourages using stated-preference surveys for learning about $u(w)$.

aspects related to family (well-being, happiness, and relationship quality), security (financial, physical, and with regard to life and the future in general), values (morality and meaning), and having options (freedom of choice, and resources). Using policy-choice scenarios, in which respondents vote between two policies that differ in how they affect aspects of well-being for everyone in the nation, we continue to find the patterns above and in addition find high relative marginal utilities for aspects related to political rights, morality of others, and compassion toward others, in particular the poor and others who struggle. While we find some differences across demographic-group and political-orientation subpopulations of our respondents, most of these main results hold across the subpopulations we examine.

We present a long list of robustness checks in Section 3.5. These include exploring the sensitivity of our findings to: estimating alternative econometric specifications; excluding alternative candidates for (non-fundamental) combination aspects from the estimation; examining subsets of our respondents based on the time they took to complete the survey; and varying survey design elements that we randomly manipulated.

In Section 3.6 we return to the two practical questions above—which items to include on a SWB survey, and how to weight them to construct an index—and discuss potential solutions, both in theory and in practice. We outline directions for thinking about implementation challenges such as avoiding double counting and reducing the number of survey questions.

Our paper contributes to a long line of research on social welfare measures, recently surveyed by Fleurbaey (2009) and Fleurbaey and Blanchet (2013).⁶ Our approach has the appealing feature that it accommodates several traditions that are often considered conflicting. It is, at the same time, "super-liberal" (Fleurbaey 2009) since we weight aspects based *solely* on our respondents' stated preferences; "welfarist" (Sen 1979a) since utility can be viewed as our exclusive crite-

6

Fleurbaey's (2009) title, "Beyond GDP: The Quest for a Measure of Social Welfare," inspired the title of our paper.

rion for judging well-being;⁷ and an application of Sen's (1985, 1992) "capabilities" approach since the vector \mathbf{w} can be considered to include both functionings (achieved states, e.g., material standard of living, health) and capabilities (opportunities for such achievements, e.g., freedoms).⁸ Indeed, as described above, we find that our respondents put a large weight on capabilities, especially in policy scenarios.⁹

The central assumption underlying our SP-survey methodology is that a person's stated preference in our abstract scenarios is an unbiased measure of her ("true") preference.¹⁰ This assumption is surely wrong; indeed, there are known ways in which stated preference is biased relative to incentivized choice, for example when one choice option is viewed as more socially desirable (Camerer and Hogarth 1999; Ding, Grewal, and Liechty 2005). Nonetheless, we believe it is more attractive to rely on what people's own stated preferences suggest

7

Sen (1979a) defines welfarism as the imposition of the following "informational constraint": "[t]he judgment of the relative goodness of alternative states of affairs must be based exclusively on, and taken as an increasing function of, the respective collections of individual utilities in these states." Sen criticizes this notion and argues that information beyond individual utilities may be needed for making moral judgments. To partially address this concern, our approach attempts to include important specific examples of such information as additional arguments in the utility function (i.e., as elements of \mathbf{w}).

8

From the capabilities-approach perspective, our empirical effort is an attempt to address the "index problem," namely the problem of choosing weights for functionings and capabilities. This problem has been considered a key obstacle to systematically applying the capabilities approach (Fleurbaey 2009) and is in general central to the construction of multi-dimensional well-being indices (Decancq and Lugo 2013). Although Sen initially opposed combining measures of capabilities and functionings into an index, he later seems to have become more sympathetic (Micklewright 2001).

9

This also gives some support to Rawls's (1971) contention that most people would prioritize basic rights ahead of other goods.

10

While we interpret our results in light of this assumption, we believe that our empirical contribution can be useful also in the context of alternative theoretical perspectives, such as that of Fleurbaey, Schokkaert, and Decancq (2009), who single out a specific survey question—a life satisfaction question—and propose to use it as the primary source of information about preferences, and those explored by Decancq, Van Ootegem, and Verhofstadt (2011), who pre-select nine survey questions and evaluate alternative weighting schemes by directly asking survey respondents how important they consider each of the nine to be. In particular, our approach can inform researchers regarding the link between different survey questions and stated preferences.

about what they themselves care about than to paternalistically rely on the opinions and introspections of "experts" (such as researchers and policymakers) regarding which aspects to track and how to weight them. Moreover, some of the objections to using stated preferences as if they are descriptive of incentivized choice may have less force when stated preferences are used normatively. In particular, while hypothetical choices in abstract scenarios may elicit meta-preferences (the preferences people *want* themselves to have), rationalized preferences (more deliberated, internally consistent preferences), or otherwise laundered preferences (e.g., omitting "dirty" preferences such as racism), it is sometimes argued that these are more relevant for evaluating welfare than the preferences that describe actual behavior. For example, our SP survey may put respondents in a deliberative frame of mind, causing them to weight emotional factors less than they do in "real life"—but doing exactly that is common prescriptive advice for avoiding emotion-induced mistakes (e.g., Camerer, Issacharoff, Loewenstein, O'Donoghue, and Rabin 2003, pp.1238-1240). We discuss related points when interpreting our results (in Section 3.4).

In Section 3.7, we mention some concerns regarding tracking well-being with surveys that we do not address. We conclude by discussing possible extensions of our approach, and we point to a few readily actionable steps suggested by our findings. Throughout, we highlight the limitations of our specific implementation and point out promising directions for further developing the agenda we propose.

3.1 Theoretical Framework

We start with the standard framework for aggregating an individual's consumption of different commodities. This framework underlies empirical expenditure- and income-based measures of well-being, including GDP; below we adapt it for conceiving a well-being index. We then discuss how this index-oriented framework can be viewed more generally as an application of choice theory,

with preferences elicited via our SP survey. We use this more general perspective to highlight the assumptions underlying the construction and use of our proposed index.

In the consumption context, an agent's well-being is represented by a continuously-differentiable utility function $u(\mathbf{c})$. The vector, $\mathbf{c} = (c_1, \dots, c_M)'$, represents the quantities of M market goods. Following a change in the consumption vector, $\Delta \mathbf{c}$, the change in utility can be approximated up to an arbitrary multiplicative scale as

$$\Delta u \approx (D_{\mathbf{c}} u(\mathbf{c}))' \cdot \Delta \mathbf{c} = \sum_{m=1}^M \frac{\partial u(\mathbf{c})}{\partial c_m} \Delta c_m \propto \sum_{m=1}^M p_m \Delta c_m. \quad (3.1)$$

The proportionality follows because, at the optimum, as long as the consumer chooses a strictly positive amount of each good c_m , each marginal utility $\frac{\partial u(\mathbf{c})}{\partial c_m}$ is equal to a Lagrange multiplier times the market price p_m . By fixing prices, $\bar{p}_1, \dots, \bar{p}_M$, at their levels in some base period and measuring the agent's consumption vector over time, the government can track a quantity index of real consumption, $\sum_{m=1}^M \bar{p}_m c_m$. For small changes in \mathbf{c} , changes in this index are approximately proportional to changes in utility.

Perhaps the biggest limitation of this consumption-based approach is that it only considers a narrow set of determinants of well-being. To broaden its scope, we follow other researchers in shifting attention away from standard consumption goods (for example, rice, TVs, train rides) and toward more fundamental aspects of well-being (for example, health, emotional states, freedoms). This approach is intended to be more general in that these fundamental aspects include all objects of desire for individuals regardless of which specific consumption goods are in an agent's choice set at a given time and place. In this framework, consumption matters for well-being through its effects on these more fundamental aspects of well-being, but non-consumption determinants of well-being are also accounted for via their effects on these fundamental aspects.¹¹

11

Consider the utility function $u(\mathbf{w})$, where $\mathbf{w} = (w_1, \dots, w_J)'$ represents the quantities of J fundamental aspects. Analogously to the consumption formula above (equation 3.1), a change in utility resulting from a change in the fundamental aspects can be approximated as

$$\Delta u \approx (D_{\mathbf{w}} u(\mathbf{w}))' \cdot \Delta \mathbf{w} = \sum_{j=1}^J \frac{\partial u(\mathbf{w})}{\partial w_j} \Delta w_j \quad (3.2)$$

Instead of measuring the agent's consumption vector \mathbf{c} , the government would measure her fundamental-aspects vector \mathbf{w} ; and instead of tracking a quantity index for standard consumption goods, the government would track $\sum_{j=1}^J \frac{\partial u(\mathbf{w})}{\partial w_j} w_j$, with the marginal utilities fixed at a base period. We term $\sum_{j=1}^J \frac{\partial u(\mathbf{w})}{\partial w_j} w_j$ the agent's *well-being index*. Since the marginal utilities are defined only up to an arbitrary multiplicative constant, so is the index. From the perspective of this theoretical framework, the purpose of a SWB survey is to measure the w_j 's.

Because there are no observable prices that can be used in place of the marginal utilities—by which here and henceforth we mean the *relative* marginal utilities—the government will need direct marginal-utility estimates in order to calculate the agent's well-being index. The purpose of our SP survey is to demonstrate a method for generating such estimates. We envision governments applying such a method on nationally representative samples and, because the marginal utilities may change as \mathbf{w} changes, doing so on a regular basis (just as prices are currently re-measured on a regular basis).

This description of our theoretical framework highlights the analogy between our proposed index and standard consumption-based indices. Our framework, however, is more general. Indeed, our SP survey could in principle be extended to elicit an individual's entire indifference map by designing the survey to elicit stated preference between *every* pair of (explicitly and

This perspective is essentially a variant of consumer theory in which preferences are defined over goods' characteristics (Lancaster 1966); the fundamental aspects can be thought of as the ultimate underlying characteristics that people care about when making choices.

fully listed) vectors of conceivable responses to a SWB survey. Regardless of the shape of preferences, ordinal welfare comparisons could then be made between any of the individual's SWB-survey occasions. In practice, however, such an unrestricted approach is unimplementable with more than a handful of aspects for two reasons. First, even if assuming transitivity and monotonicity eliminated the need to directly compare *every* pair of aspects, the number of pairwise comparisons required on the survey would grow exponentially with the number of elements in \mathbf{w} . Second, each such pairwise comparison would require respondents to compare two long vectors of aspects, arguably an excessive cognitive demand on survey respondents. Moreover, even if the list of aspects were short, stated-preference data may be less reliable the farther the vectors to be compared are from the respondent's current \mathbf{w} because it may be more difficult for respondents to introspect regarding distant, unfamiliar situations.

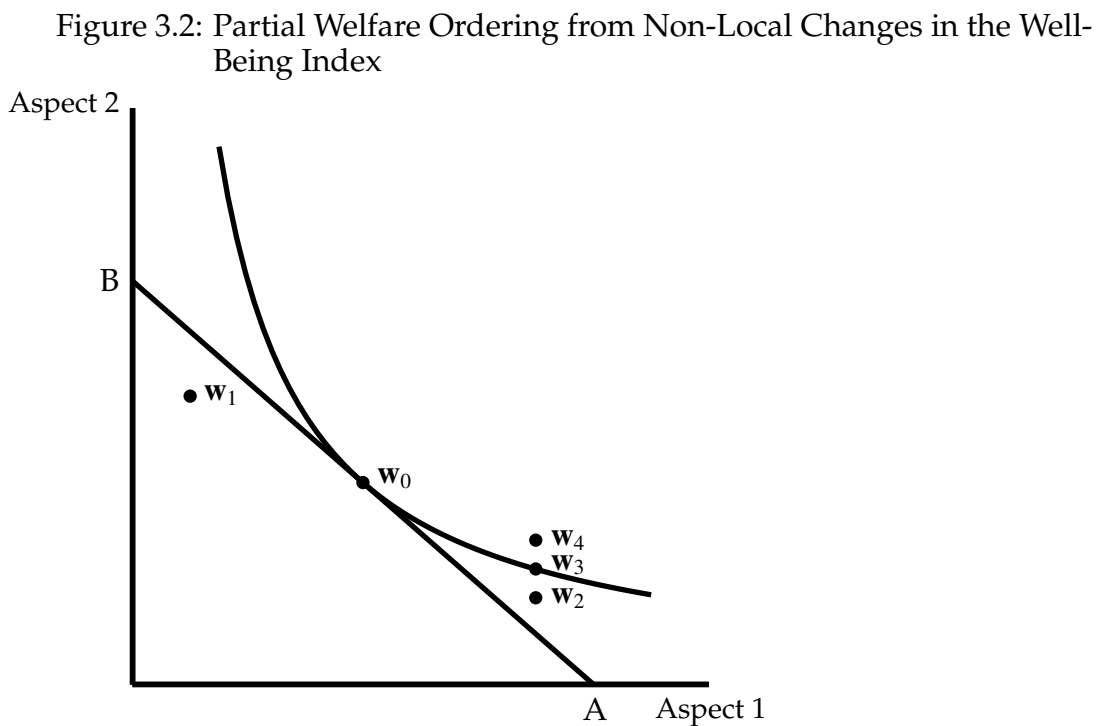
Our approach in this paper—and the resulting design of our SP survey detailed in Section 3.3 below—can be understood as a more practical version of this generalized procedure, whereby we restrict ourselves in two ways. First, we elicit preferences only locally at the status quo, where we think stated-preference data are most reliable.¹² Second, we assume that preferences can be represented by a continuously-differentiable utility function, and hence are locally linear. Local linearity makes the SP survey more feasible: the absence of complementarities allows us to alleviate respondents' cognitive task by presenting them with a series of pairwise comparisons that involve a tradeoff between as few as two aspects at a time deviating from current \mathbf{w} ; and the fact that the functional form of local preferences is known reduces the number of SP-survey questions needed to estimate the (local) indifference surface. The continuous-differentiability assumption underlies the discussion surrounding equation 3.2 above: as long as \mathbf{w} remains within a small neighborhood around the \mathbf{w} prevailing when a SP survey was conducted, the well-being index can be used to make

¹²

While our scenarios do not explicitly frame the choice as being relative to respondents current aspect levels, we believe that this is the natural interpretation (see language in the example scenario in the introduction). One could more explicitly instruct respondents to interpret the choice this way by simply adding a few words to the scenarios' preamble.

welfare comparisons between SWB-survey occasions.

Such a local welfare ordering may often be sufficient, as many individuals may have reasonably stable w 's for long periods of time. However, under some circumstances w may drift away (as time goes by) or even jump discontinuously (perhaps due to a change in policy or in personal circumstances). Between a w within the neighborhood where a SP survey was conducted and a w outside that neighborhood, the index does not provide a complete welfare ordering. Nonetheless, under additional assumptions on preferences, the index could provide a *partial* welfare ordering. For example, suppose that preferences are convex. Figure 3.2 is adapted from Sen (1979b) who discusses how convexity generates a partial ordering in the context of a real consumption index. The



line AB—the tangent to the indifference curve going through w_0 , whose slope is in our case estimated with a SP survey at w_0 —partitions all bundles into a southwest set and a northeast set. Using the weights calculated from a SP survey at

w_0 , the index values decrease from w_0 to every aspect bundle in the southwest and increase from w_0 to every bundle in the northeast. Thus if the index value decreases from w_0 to any bundle (e.g., w_1 in the figure), no matter how far away, then due to convexity, we can conclude that the individual is worse off. If the index value increases from w_0 , however, the individual could be worse off (w_2 in the figure), indifferent (w_3), or better off (w_4). If a new SP survey were conducted at the new bundle, then it is possible that w_0 would lie in the new southwest set, completing the ordering by revealing that the new bundle is unambiguously better than w_0 . It may also be possible to make a partial ordering more complete by applying transitivity to a sequence of unambiguous pairwise comparisons.

In summary, with a given set of weights estimated at w_0 , our index provides a complete local ordering, and a partial global ordering, of w 's. Locally, increases and decreases in the index are both interpretable as reflecting welfare changes, while globally, comparisons require more involved logic such as that above.

Although in this paper we focus primarily on survey-based measures of the fundamental aspects that comprise w , our theoretical framework also applies when some or all of the aspects are measured objectively. For example, some dimensions of health could be measured with physiological tests, and, arguably, some freedoms could be quantified. Indeed, widely-used indices such as the UN's Human Development Index and Okun's "misery index" (the sum of the inflation and the unemployment rates) consist entirely of objective measures that are combined by using ad hoc weights. Regardless of whether the components of w are measured objectively or subjectively, we propose using a data-driven method for estimating the marginal utilities; our SP survey is an attempt at implementing such a method. Even with objective measures that have observable prices, directly estimating the marginal utilities may be considered an alternative to making the assumptions necessary for using prices as weights.

While our theory above focuses on constructing a well-being index for a single agent, in order to construct a national index in practice, governments

would need to, first, construct indices for many people and, second, aggregate them. To construct indices for many people, a method such as our SP survey could be used to estimate marginal utilities for each person in a representative sample. Since doing so may require a long (and hence potentially expensive) survey—especially if \mathbf{w} includes many aspects—in practice pooling data within respondent subpopulations may sometimes be a required compromise. Given our own very limited resources, when demonstrating our methodology in Section 3.4 our main specification pools data across *all* respondents—something that governments should avoid, as we discuss in Section 3.6.

How to aggregate utility across individuals is a central question of welfare economics and an active area of research in the literature on social choice. Although this paper focuses on constructing an individual-level well-being index, in principle our framework and empirical contribution are compatible with a variety of approaches to aggregation, as we briefly discuss in Section 3.7.

3.2 Aspects of Well-Being

A major obstacle to any real-world application of our theoretical framework is that no one knows which fundamental aspects comprise the vector \mathbf{w} . Indeed, different authors have proposed different sets of aspects as important components of well-being. Our treatment of aspects as arguments of utility requires that for our purposes, any proposed set must be *exhaustive*, i.e., include *all* arguments of preferences; and it must comprise aspects that are *nonoverlapping*, i.e., that are conceptually distinct.

Our approach in this paper is to construct as comprehensive a list of candidate fundamental aspects as we practically can. We additionally include what we believed would be broader, non-fundamental "combination aspects"—by which we mean facets of well-being that are not themselves fundamental but contain information regarding multiple fundamental aspects—which might capture more of the variation in u . Our comprehensiveness has three advantages.

First, it reduces the risk of missing important components of \mathbf{w} , thereby making the list closer to exhaustive. Second, it allows us to minimize the influence of our own ex ante beliefs on the set that emerges as important from our analysis.¹³ Third, it renders our results as broadly useful as possible, since different researchers can focus on the subset of our results that pertains to the aspects they believe comprise \mathbf{w} —or to those they happen to have data on in an existing social survey. On the other hand, our attempt to be comprehensive has the drawback of increasing the likelihood that different aspects on our list overlap with each other. Our analysis in Section 3.5, in which we exclude some potentially overlapping aspects from the analysis, suggests that such possible overlap does not meaningfully affect our marginal utility estimates. However, in selecting which aspects to include in a well-being index, a method will be required for ensuring that fundamental aspects are not double-counted. We summarize a proposal for such a method in Section 3.6; we discuss it in more detail and formalize it in Appendix section C.4.

In this section we summarize our method for compiling our master list of 136 aspects of well-being (see Table 3.2 for a version of the list). The list, as well as much more detail regarding the process of compiling it, dividing it into different sub-lists, and creating different versions of it, is available in Appendix section C.1.

Our list draws from six classes of survey measures. First, we include single-question SWB measures, modeled after the SWB questions most commonly asked in large-scale social surveys (for example, those asked in or proposed for the U.K. survey discussed above). These include mostly measures that are considered *evaluative/cognitive* (e.g., life satisfaction)—i.e., measures based on questions that may trigger respondents to engage deliberative cognitive processes in order to evaluate their life—and those that are considered *hedonic/affective* (e.g.,

¹³

That said, in compiling the list we draw exclusively on English-speaking sources, introducing a cultural bias—but one compatible with our respondents'. In addition, "dirty" aspects (such as racist objectives) are typically absent from our sources, but as we discuss in Section 3.4, the few aspects on our list that could be considered "dirty" (e.g., social status) are ranked very low by our SP-survey respondents anyway.

felt happiness)—i.e., measures that are aimed at eliciting respondents positive or negative feelings.

Second, we include measures based on items in multi-question survey measures of SWB. These are primarily drawn from scales commonly used in psychology, such as the PANAS (Positive and Negative Affect Scale).

The third and largest class contains aspects of well-being proposed by prominent economists, psychologists, and philosophers that are not typically elicited on large surveys. We drew on proposals from the Stiglitz Commission (Stiglitz, Sen, and Fitoussi 2009), the systematic compilation effort by Alkire (2002), as well as many classic sources (e.g., Maslow 1946; Sen 1985; Nussbaum 2000) and more recent contributions (Seligman and Diener 2004; Loewenstein and Ubel 2008; Graham 2011). A complete list of the works we reviewed, including references by aspect, is given in Appendix section C.1.3. The many aspects in this class include some that can be understood as capabilities, i.e., access to resources, choice sets, and freedoms. The aspects also include some that would be considered *eudaimonic* SWB measures (for example, having a meaningful life; Ryff 1989). Such measures relate to human thriving or flourishing; the Greek word *eudaimōn* is commonly translated to mean happy in an Aristotelian sense, i.e., as associated with having a meaningful, valuable, or worthwhile life.

The fourth class of measures resulted from our own introspection and discussion. Some of our proposed additions were confirmed to be important in our past work (Benjamin, Heffetz, Kimball, Rees-Jones 2012), and others resulted from extensive discussions among ourselves and with colleagues. Some reflect our attempt to break down important parts of life into more fundamental aspects. For example, while many writers have proposed that religion is important for well-being, we refined "religion" into 15 aspects of well-being that may help explain the value of religion but that are also valued by many nonreligious people (e.g., "you having people around you who share your values, beliefs and interests").

While these four classes of measures represent our attempt to include fun-

damental aspects in our list, our fifth and sixth classes serve different purposes. The fifth class represents our attempt to formulate combination-aspect survey questions that, if broad enough, might even serve as good empirical proxies for u itself, thus possibly obviating the need for an index. These include novel (in wording, not necessarily in concept), evaluative well-being measures, such as "how much you like your life" and "the overall well-being of you and your family."

Finally, as a sixth class, we crafted survey versions of "objective" indicators that are widely-used as measures of well-being, such as the rates of GDP growth, inflation, and unemployment, or income inequality. The weights respondents put on such measures can serve as a benchmark against which we can compare measures from our first five classes.¹⁴

After compiling an initial list, we revised it according to several criteria. To make its length more manageable, we combined similar items into single measures (but we preserved commonly-used survey questions close to their original form). To reduce subject confusion and response error, we oriented all items so that rating higher would conventionally be considered desirable; for example, "not feeling anxious." We further edited items in order to use vocabulary that would be understandable by most respondents in a national sample.

The final list of 136 aspects includes 113 "private good" aspects—relating to an individual's own well-being (e.g., "your health")—and 23 "public good" aspects (also labeled *public*-aspects)—relating to an entire society's well-being (e.g., "equality of opportunity in your nation"). Among the private-good aspects, we distinguish between what we label *you*-aspects—108 that pertain to the respon-

14

In principle, we could have additionally included receipt of different amounts of money as an aspect on our list. Doing so would have allowed us to scale the estimated marginal utilities of the nonmoney aspects, converting them to dollar units, in turn enabling one to sum equivalent variation across individuals. In practice, however, this approach would have significantly complicated our current (purposefully simplified, proof-of-concept) survey design. For example, dollar amounts would require their own quantitative scales that could not be made easily comparable to the rating scales of all other aspects without considerable design changes (see the discussion in Section 3.3.3 below).

dent but could in principle pertain to everyone (e.g., "your health")—and *you-only*-aspects—5 that pertain to the respondent and could *not* meaningfully and distinctly pertain to everyone at the same time, for example due to their being inherently relative (e.g., "your social status").

Finally, from each of the 108 *you*-aspects we constructed two additional aspect versions: an *everyone*-aspect that pertains to everyone in a nation (e.g., by replacing "your health" with "people's health"); and an *others*-aspect that pertains to typical others (e.g., "others' health"). In the next section, we explain the purpose of those aspect versions and discuss them further.

3.3 Survey Design

The core of our online SP survey consists of 30 hypothetical-choice scenarios, one per screen. They are preceded by a screen of detailed instructions and followed by a multi-screen exit questionnaire.

3.3.1 Scenario Screens

An example scenario, as it appears on the screen, was reproduced in the introduction. Each such screen has three components. First, the *preamble* frames the scenario as a choice between two options, neutrally labeled "Option 1" and "Option 2," that have different consequences over the next four years. Second, the *aspect table* describes the difference in consequences between the two options. Finally, the *choice question* elicits a participant's stated preference between the two options.

Preamble.—The preamble appears in one of two versions. The first version (reproduced in the introduction) introduces *personal-choice* scenarios. Since much of the discourse regarding SWB surveys is focused on private-good aspects, personal choice seems the relevant setting for eliciting these aspects' weights

through respondents' pairwise decisions that trade them off.

The second preamble version introduces *policy-vote* scenarios: the opening clause "Imagine you are **making a personal decision**" is replaced with the clause "Imagine that you and everyone else in your nation are **voting on a national policy issue**."¹⁵ Policy-vote scenarios have two purposes. First, as with standard public goods, our 23 *public*-aspects cannot typically be affected by one individual's personal choice—but are routinely traded off in policy-vote contexts. Second, even for *you*-aspects, if a national SWB survey is to be used for evaluating policy, it may be useful to elicit the relative weights also in a setup where the aspects pertain to everyone (and are traded off by policy in the same way for everyone). Due to other-regarding preferences, for example, these *everyone*-weights could differ from their corresponding *you*-weights elicited in personal-choice scenarios. While our empirical effort is focused on personal scenarios, we also explore such personal-vs.-policy comparisons below.

The rest of the preamble is identical across all scenarios. Designed to elicit participants' "single-period" utility, it explicitly limits the duration of the predicted difference between the options. While four years is a somewhat arbitrary duration, it does not seem unreasonable as a time frame for assessing policy (for example, it is the length of the term of the US President) as well as personal choices. The preamble ends with a sentence that effectively asks participants to imagine that anything not explicitly stated to differ is held constant.

Aspect table.—Each row of the aspect table compares the two options in terms of one aspect, with an "X" positioned to indicate that either Option 1 or 2 rates "much higher," "somewhat higher," or "slightly higher" on that aspect. The

15

We chose this voting frame for two reasons. First, it is designed to imitate a situation that, while hypothetical, is as close as possible to the policy choice setup people have real-world experience with; while most people are never in a position to actually choose a policy that would get implemented, people often face choices over real policies in the voting booth. Second, the frame is designed to elicit participants' *own* preferences. While these preferences might well incorporate a concern for others, we did *not* want the choices to put extra weight on others out of concern that these others would be left out of the decision-making process. For this reason the question explicitly states that "you and everyone else in your nation" are voting.

"about equal" column in the middle never contains an "X"; it serves as a reminder to participants that unlisted aspects are to be considered as affected equally by the two options.

Personal scenarios draw aspects randomly from the set of 113 private aspects (which consists of 108 *you*- and 5 *-you-only*-aspects). The policy scenarios we analyze in this paper instead draw aspects randomly from the set of 108 *everyone*- and 23 *public*-aspects; these 131 aspects are effectively public goods because they affect everyone in the same way. Each respondent faces, in random order, 11 personal scenarios, 5 of these policy scenarios, and 14 additional exploratory versions of policy scenarios that we do not analyze in this paper.¹⁶

The number of aspects (or rows) in a scenario's aspect table is randomly drawn from the set {2, 3, 4, 6}. While a shorter table may be easier for respondents to read and think through, a longer one improves statistical power for identifying marginal utilities.

The rating of each aspect—i.e., the location of the "X" in each row—is randomly drawn from the six feasible ratings. However, we place two restrictions on the combination of ratings within a scenario. First, scenarios with an even number of aspects must be *balanced*: exactly half of the aspects favor Option 1 and exactly half favor Option 2. Second, scenarios with four or six aspects must additionally be *symmetric*: each rating in favor of Option 1—i.e., "much higher," "somewhat higher," or "slightly higher"—is matched by a rating of the same intensity in favor of Option 2 on another aspect.¹⁷

¹⁶

These additional versions are designed to explore issues related to other-regarding preferences that are beyond the scope of this paper. (For example, to what extent do people's votes on policy reflect their willingness to sacrifice their own utility for increasing others'?) These policy scenario versions draw aspects from sets that consist of different combinations of *you*-, *you-only*-, *others*-, and *public*-aspects.

¹⁷

We require 2-aspect scenarios to be balanced because, otherwise, half of them are expected to elicit a trivial choice, as one of the options would rank higher on all aspects. By placing no restrictions on 3-aspect scenarios, we allow such trivial cases to occur (with 25 percent probability), and we use them as a secondary robustness check to identify respondents who might have answered at random (see footnote 29 below). Finally, we require 4- and 6-aspect scenarios to be balanced and symmetric because our pre-tests suggested that otherwise, participants faced with

Choice question.—The choice response scale is identical across all scenarios. It is designed to elicit intensity of preference on a six-point scale ("Much prefer Option 1," "Somewhat prefer Option 1," "Slightly prefer Option 1," "Slightly prefer Option 2," etc.). To discourage "lazy" responses, we omitted an "indifferent" option; our "slightly" options are intended to allow for nearly-indifferent choices.

3.3.2 Instructions and Questionnaire

The instructions screen is reproduced in Appendix section C.2. Respondents could reopen it from every scenario screen by clicking a hyperlink. It includes an example aspect table that is more complex than that shown in the introduction, illustrating and explaining more possibilities. The instructions emphasize a number of scenario design points, including: the distinctions between personal-choice and policy-vote scenarios; that the two options differ *only* on the consequences listed in the aspect table; and that "The items and their rankings in the tables are randomly chosen by the computer so that we [the researchers] learn as much as possible from your choices."¹⁸

In addition, the instructions explain that in each row of the aspect tables, one word is emphasized in boldface type (in the example in the introduction, **you** and **your**). Participants are asked to "pay careful attention to the emphasized words, and interpret a consequence with the following emphasized words as affecting the following people:"¹⁹

these longer scenarios may adopt "visual shortcut" heuristics—such as choosing an option that ranks better on most aspects—and pay less attention to the identities of the aspects. We compare results estimated separately from 2-, 3-, 4-, and 6-aspect scenarios in Section 3.5.

¹⁸

This randomization disclosure is intended to prevent respondents from perceiving random combinations of aspects as reflecting an intentional design decision to construct a particular scenario. Such mistaken inferences could give rise to undesired experimenter-demand effects.

¹⁹

We included the bolding and this "legend" (reproduced here as it appears on the screen) because pre-tests without the bolding indicated that participants might quickly skim the aspect tables, mistakenly assuming that, for example, all aspects apply to only them personally. The

you/your: affects only you (and, when stated, your family or close friends).

others/others': does not affect you, your family, or your friends—but does affect other people. The table indicates the average effect on other people in your nation.

nation/society/people: affects everyone in your nation (including you, your family, and your friends).

world/humanity: affects everyone in the world.

Once participants complete the scenarios, they fill out an exit questionnaire. We ask participants, in both a multiple-choice question and an open-ended question, whether they understood what we were asking them to do (in the multiple choice, 92.5 percent answered "always" or "mostly"; 7.5 percent answered "not really"). We also ask basic demographic questions, as well as questions about ideology, political party affiliation, and religiosity.

3.3.3 Design versus Theory

As discussed above, our SP survey is intended as a first-pass demonstration of feasibility. As such, it is a considerably simplified version of the theory-based ideal that should guide governments as they design their surveys. We now briefly describe what a theoretically ideal survey might involve, and we highlight a few key deviations of our SP survey from that ideal.

In an ideal application of our theory, a SP-survey component would follow a SWB-survey component in a single, combined survey. The SWB component would elicit a respondent's current aspect levels (i.e., her **w**). Each of the J fundamental-aspect questions would have its own scale: while a subjective scale with verbal labels may be a natural choice for some aspects, for other

bolding scheme allows us to keep the aspects short and simple and at the same time visually clear and coherent. The legend provides respondents with a quick reference that clarifies the bolded words' intended meaning.

aspects it may be possible to use an objective scale with quantitative units. After respondents report their current w in the SWB-survey component, the SP component would elicit their choices between pairs of options, where each option involves a small change from the current w ; these small changes would be spelled out using each aspect's own units. With sufficiently many such choices, each respondent's vector of marginal utilities could then be estimated.

Our SP survey deviates from this ideal in a number of ways. First, it is a stand-alone survey, rather than the second component in a combined SWB+SP survey. We concentrate our efforts on a stand-alone SP survey since SWB surveys are already conducted routinely and do not require a demonstration of feasibility. Second, our survey uses verbal, relative rating scales that are identical for all aspects ("much," "somewhat," and "slightly higher") rather than stating differences using each aspect's own units. We do this to simplify and streamline the survey and its instructions. It also allows us to interpret relative marginal-utility estimates as informative regarding aspects' relative "importance" because the aspect ratings are put in units that are arguably comparable, namely respondents' judgment of what constitutes "slightly," "somewhat," or "much" more of the aspect (but see Section 3.6.2 for discussion of how, with additional data, aspects could be compared in terms of predictive power for the index). Third, our survey elicits few SP questions from each respondent, and in our marginal utility estimates below we pool the data across respondents. Doing so keeps the survey short—a crucial feature given our convenience sample—but theoretically would only be justified if respondents not only use the scales the same way but also have the same local slopes of indifference surfaces. We return to this last point in Section 3.6.3.

3.4 Empirical Results: Marginal Utility Estimates

Our SP-survey respondents were recruited during December 2011 by Clear Voice Research, a private firm that invites individuals to "start sharing their

Table 3.1: Respondent Demographics

		All (N = 7391)	Completes (N = 5397)	Primary Sample (N = 4608)	Census Etc.
Marital Status	Married	59.3	58.9	59.8	48.8
	Never Married	24.3	25.5	23.4	32.1
	Other	16.4	15.6	16.8	19.1
Highest Education Level Completed	High School Grad	23.2	21.9	21.4	42.9
	Some College	40.7	39.8	41.0	28.9
	Bachelor's Degree	24.3	25.4	25.5	17.7
	Graduate Degree	11.5	12.7	12.0	10.4
Age	20-29	19.7	21.1	18.0	18.9
	30-39	18.3	19.5	18.4	17.8
	40-49	19.3	20.0	20.0	19.3
	50-64	20.8	20.4	22.0	26.1
	65 and older	21.9	19.0	21.5	17.9
Income	less than \$20,000	17.9	18.1	17.4	19.8
	\$20,000-39,999	27.9	27.0	27.9	21.7
	\$40,000-49,999	10.9	10.2	10.8	8.9
	\$50,000-74,999	19.8	20.0	20.5	17.7
	\$75,000-99,999	11.3	11.7	11.6	11.4
	\$100,000 and above	12.1	13.0	11.8	20.4
Region	Midwest	23.0	23.2	24.3	21.7
	Northeast	19.8	20.0	19.3	17.9
	South	34.0	33.4	33.8	37.1
	West	23.2	23.4	22.6	23.3
Race	White	76.6	75.2	78.2	63.7
	Black	9.8	10.1	9.6	12.2
	Hispanic/Latino	7.7	8.2	6.4	15.4
	Asian	3.7	4.2	3.5	4.7
	Other	2.2	2.2	2.2	4.0
Household Size	1	18.0	17.7	18.2	26.7
	2	35.2	33.8	35.1	32.8
	3	18.8	19.1	18.6	16.1
	4 and above	27.8	29.2	27.9	24.4
Employment Status	Employed	53.7	55.9	53.3	57.4
	Unemployed	8.6	8.7	8.8	6.9
	Not in labor force	37.6	35.4	37.8	35.6

Notes : All numbers are percentages. "All": respondents who began the survey. "Completes": respondents who completed all scenarios. "Primary Sample": respondents who took at least 8 minutes to complete the survey. Sources: Authors' survey, 2010 American Community Survey, 2010 Census, 2011 Current Population Survey.

voice" and "make a little money" by participating in online surveys. We aimed at a sample that, although not a random sample, would resemble the adult (20+) US population on the demographics listed in Table 3.1.

3.4.1 Respondent Demographics

Table 3.1 reports the demographic distribution of the 7,391 respondents who began our survey (the "All" column); the 5,397 who completed it ("Completes"); and the 4,608 included in our main analysis below ("Primary Sample").²⁰ This primary sample excludes respondents who completed the survey in less than eight minutes; our robustness analysis in Section 3.5 below suggests that including them does not affect our results qualitatively but increases measurement error. The table shows that the three groups are similar on observables.

The rightmost column reports figures from the 2010 American Community Survey, 2010 Census, and 2011 Current Population Survey (see Table C.2 in the Appendix). Relative to the US population, our respondents are more likely to be married, college-educated, and white, and less likely to have very high income, be Hispanic, and live alone. Our respondents may of course also differ on unobservables.

3.4.2 Personal Choices: Benchmark Specification and Results

Our main results are reported in the "Personal" panel of Table 3.2. Recall from Section 3.3 that each respondent faced 11 personal scenarios where the two choice options differ on 2, 3, 4, or 6 of the 113 personal aspects. Pooling all such scenarios across all respondents, we report results from the following OLS

²⁰

Due to a programming error, the first 1,936 primary-sample respondents faced scenarios in which aspects were unintentionally drawn from only 108 of the intended 113 personal and 131 policy aspects. As a result, we have more data—and tighter estimates—on some aspects. Excluding these 1,936 early respondents has very little effect on our main estimates.

regression:

$$\text{StatedPreference}_s = \alpha + \mathbf{AspectRatings}'_s \cdot \boldsymbol{\beta} + \varepsilon_s \quad (3.3)$$

Each observation s captures the information from a single scenario faced by a respondent, corresponding to a single survey screen like the example in the Introduction. $\text{StatedPreference}_s$ encodes the response to the choice question. $\mathbf{AspectRatings}'_s$, a 113-element vector, encodes the differences between the two options; all of its entries are 0 except for the 26 entries representing the aspects on which the options differ. We cluster standard errors at the respondent level.

To the six points on the choice scale ("Much prefer Option 1," etc.) we assign the six numerical values (-1, -0.47, -0.14, +0.14, +0.47, +1), and to the seven columns in the aspects table ("Option 1 much higher," etc.) we assign the values (-1, -0.83, -0.75, 0, +0.75, +0.83, +1). As described in Section 3.5 below, these numerical values were estimated from the data using a nonlinear ordered probit model, constraining the scales to be symmetric (to economize on parameters) and range from -1 to +1. While we prefer using these estimated scales, misspecifying the scales should have little effect on the estimated aspect coefficients relative to each other. Indeed, for the personal scenarios, the correlation between the coefficients reported in table 2 and those estimated with linear codings (i.e., choice scale: (-3, -2, -1, +1, +2, +3) and aspect ratings: (-3, -2, -1, 0, +1, +2, +3)) is 0.998. We find similarly high correlations (0.99) with coefficients estimated from a probit or logit model where we collapse the choice scale to a binary variable (prefer Option 1 vs. Option 2) and use the estimated scales for the aspect columns.

Here we report OLS for maximum transparency, and for simplicity we assume for now that respondents are identical in both their marginal rates of substitution and their use of the response scale. As reported in Section 3.5 below, our results are essentially unaffected when we relax many of the restrictions imposed by this specification. We provide some evidence on heterogeneity across respondent subpopulations later in this section.

Table 3.2: Relative Marginal Utility Estimates

Aspect	Personal			Policy		
	Coef.	S.E.	Rank	Coef.	S.E.	Rank
freedom from corruption, injustice, and abuse of power in your nation				0.39	0.026	0a
the overall well-being of you and your family	0.46	0.016	1	0.33	0.033	3
the happiness of your family	0.43	0.017	2	0.24	0.024	21
your health	0.42	0.017	3	0.29	0.025	6
you being a good, moral person and living according to your personal values	0.4	0.017	4	0.35	0.025	2
the quality of your family relationships	0.37	0.017	5	0.25	0.024	13
society helping the poor and others who struggle				0.30	0.024	5a
the morality, ethics, and goodness of other people in your nation				0.29	0.024	5b
your financial security	0.34	0.017	6	0.28	0.023	8
freedom of speech and people's ability to take part in the political process and community life				0.29	0.025	6a
the well-being of the people in your nation				0.29	0.024	6b
your mental health and emotional stability	0.34	0.016	7	0.25	0.025	15
your sense of security about life and the future in general	0.33	0.016	8	0.26	0.024	12
you having many options and possibilities in your life and the freedom to choose among them	0.32	0.017	9	0.35	0.034	1
the amount of freedom in society				0.27	0.025	9a
your sense that your life is meaningful and has value	0.32	0.017	10	0.27	0.023	9
how satisfied you are with your life	0.31	0.017	11	0.18	0.033	53
you feeling that you have enough time and money for the things that are most important to you	0.30	0.017	12	0.21	0.023	32
how much you like your life	0.30	0.017	13	0.19	0.031	46
how peaceful, calm, and harmonious your life is	0.29	0.017	14	0.24	0.024	18
your nation being a just society				0.25	0.023	14a
your feeling of independence and self-sufficiency	0.29	0.016	15	0.23	0.024	25
your pride and respect for yourself	0.29	0.017	16	0.19	0.024	44
your sense that you are standing up for what you believe in	0.29	0.017	17	0.21	0.025	33
your sense that you are making a difference, actively contributing to the well-being of other people, and making the world a better place	0.29	0.017	18	0.32	0.025	4
how low the rate of unemployment is in your nation				0.24	0.024	18a
how much you enjoy your life	0.29	0.016	19	0.24	0.025	17

Table 3.2 – continued from previous page

trust among the people in your nation				0.24	0.023	19a
equality of opportunity in your nation				0.24	0.023	19b
the extent to which you feel the things you do in your life are worthwhile	0.28	0.016	20	0.24	0.032	23
your physical safety and security	0.28	0.016	21	0.24	0.023	22
the well-being of the people in the world				0.24	0.024	21a
you "being the person you want to be"	0.28	0.017	22	0.17	0.024	62
your freedom from being lied to, deceived, or betrayed	0.28	0.017	23	0.3	0.026	5
people getting the rewards and punishments they deserve				0.23	0.025	23a
you having people you can turn to in time of need	0.28	0.016	24	0.28	0.024	7
the extent to which you "have a good life"	0.28	0.016	25	0.24	0.032	19
the condition of animals, nature, and the environment in the world				0.22	0.026	25a
you having the people around you think well of you and treat you with dignity and respect	0.27	0.017	26	0.26	0.023	11
how grateful you feel for the things in your life	0.27	0.017	27	0.22	0.032	26
your sense of control over your life	0.27	0.017	28	0.24	0.023	20
how much love there is in your life	0.27	0.016	29	0.20	0.025	42
how much you appreciate your life	0.27	0.016	30	0.18	0.033	58
how much of the time you feel happy	0.27	0.017	31	0.20	0.025	41
your sense that things are getting better and better	0.27	0.016	32	0.19	0.032	49
your sense that you know what to do when you face choices in your life	0.26	0.016	33	0.18	0.023	55
the extent to which humanity does things worthy of pride				0.21	0.024	33a
you having people around you who share your values, beliefs and interests	0.26	0.016	34	0.21	0.024	29
how often you smile or laugh	0.26	0.017	35	0.14	0.024	82
your ability to dream and pursue your dreams	0.26	0.016	36	0.25	0.024	14
your chance to live a long life	0.26	0.016	37	0.19	0.025	45
the amount of love in the world				0.20	0.025	37a
how fulfilling your life is	0.26	0.017	38	0.15	0.037	78
how happy you feel	0.26	0.016	39	0.23	0.034	24
how glad you are to have the life you have rather than a different life	0.25	0.016	40	0.15	0.034	73
your passion and enthusiasm about things in your life	0.25	0.016	41	0.15	0.024	77
you feeling alive and full of energy	0.25	0.016	42	0.15	0.023	76
your ability to fulfill your potential	0.25	0.016	43	0.21	0.022	28
how low the rate of inflation is in your nation's economy				0.19	0.024	43a
your ability to be yourself and express yourself	0.25	0.016	44	0.19	0.023	47
the absence of stress in your life	0.25	0.017	45	0.15	0.024	74

Table 3.2 – continued from previous page

your ability to keep good perspective in your life	0.25	0.017	46	0.18	0.025	57
your sense of purpose	0.25	0.017	47	0.21	0.023	35
the amount of order and stability in your life	0.24	0.016	48	0.18	0.023	56
your freedom from pain	0.24	0.017	49	0.26	0.022	10
you feeling that things are going well for you	0.24	0.016	50	0.21	0.035	34
the quality of your romantic relationships, marriage, love life or sex life	0.24	0.017	51	0.16	0.026	69
the absence of worry in your life	0.23	0.016	52	0.20	0.024	38
your sense that you are competent and capable in the activities that matter to you	0.23	0.017	53	0.20	0.024	39
your physical comfort	0.23	0.015	54	0.12	0.023	88
the amount of order and stability in society				0.18	0.025	54a
how full of beautiful memories your life is	0.23	0.016	55	0.11	0.032	90
your success at accomplishing your goals	0.23	0.017	56	0.21	0.023	36
your ability to shape and influence the things around you	0.23	0.016	57	0.19	0.024	50
the rate of economic growth (GDP growth) over time in your nation				0.18	0.026	57a
you feeling that your life has direction	0.22	0.017	58	0.16	0.023	67
how rewarding the activities in your life are	0.22	0.016	59	0.16	0.034	68
you getting the things you want out of life	0.22	0.017	60	0.15	0.033	79
your sense of optimism about your future	0.22	0.016	61	0.22	0.034	27
the average income of people in your nation (GDP per capita)				0.17	0.024	61a
you feeling that you have been fortunate in your life	0.22	0.016	62	0.18	0.033	54
the extent to which your nation does things worthy of pride				0.17	0.024	62a
your knowledge, skills, and access to information	0.22	0.016	63	0.21	0.023	31
the absence of sadness in your life	0.22	0.017	64	0.2	0.024	37
how often you can feel relaxed instead of feeling your life is hectic	0.22	0.016	65	0.13	0.023	85
your sense of achievement and excellence	0.21	0.016	66	0.16	0.025	65
equality of income in your nation				0.16	0.024	66a
the absence of frustration in your life	0.21	0.016	67	0.17	0.025	61
your freedom from emotional abuse or harassment	0.20	0.017	68	0.25	0.025	16
you not feeling depressed	0.20	0.016	69	0.15	0.025	80
your ability to have and raise children	0.20	0.017	70	0.18	0.024	59
you feeling that you are part of something bigger than yourself	0.20	0.016	71	0.17	0.024	60
you having many moments in your life when you feel inspired	0.20	0.016	72	0.15	0.025	71
the amount of pleasure in your life	0.20	0.017	73	0.19	0.024	43
your personal growth	0.19	0.016	74	0.14	0.024	81

Table 3.2 – continued from previous page

	0.19	0.024	74a	
the happiness of your friends				
how often you are able to challenge your mind in a productive or enjoyable way	0.19	0.016	75	0.15 0.024 75
the absence of anger in your life	0.19	0.017	76	0.19 0.025 51
the quality of your sleep	0.19	0.016	77	0.09 0.025 96
you feeling that you understand the world and the things going on around you	0.19	0.016	78	0.15 0.025 70
your sense that everything happens for a reason	0.18	0.016	79	0.09 0.024 95
the absence of fear in your life	0.18	0.017	80	0.2 0.026 40
how easy and free of annoyances your life is	0.17	0.016	81	0.07 0.025 98
how desirable your life is	0.17	0.016	82	0.09 0.035 97
your ability to fully experience the entire range of healthy human emotions	0.17	0.016	83	0.19 0.024 48
your ability to use your imagination and be creative	0.17	0.017	84	0.16 0.023 66
your sense of discovery and wonder	0.16	0.016	85	0.11 0.024 91
freedom of conscience and belief in your nation				0.13 0.024 85a
how close your life is to being ideal	0.16	0.017	86	0.12 0.032 87
your sense of community, belonging, and connection with other people	0.16	0.017	87	0.21 0.024 30
you not being lonely	0.15	0.016	88	0.17 0.024 64
the total size of your nation's economy (GDP)				0.12 0.024 88a
you feeling that you are understood	0.15	0.017	89	0.19 0.024 52
your absence of internal conflict (conflict within yourself)	0.15	0.016	90	0.15 0.024 72
the absence of regret you feel about your life	0.14	0.016	91	0.02 0.033 105
you not feeling anxious	0.13	0.017	92	0.09 0.024 94
how interesting, fascinating, and free of boredom your life is	0.13	0.016	93	0.03 0.023 103
you having new things, adventure, and excitement in your life	0.12	0.016	94	0.13 0.024 86
the amount of fun and play in your life	0.12	0.016	95	0.11 0.024 89
your sense of connection with the universe or the power behind the universe	0.12	0.017	96	0.10 0.025 93
how much beauty you experience in your life	0.11	0.017	97	0.04 0.025 101
your material standard of living	0.11	0.016	98	0.06 0.026 100
the overall quality of your experience at work	0.10	0.017	99	0.14 0.023 83
you having a role to play in society	0.10	0.016	100	0.17 0.024 63
your opportunities to participate in ceremonies, cultural events, and celebrations that are meaningful to you	0.09	0.016	101	0.11 0.024 92
how often you become deeply engaged in your daily activities (so deeply engaged that you lose track of time)	0.09	0.017	102	0.01 0.023 106

Table 3.2 – continued from previous page

your rating of your life on a ladder where the lowest rung is "worst possible life for you" and the highest rung is "best possible life for you"	0.09	0.016	103	0.04	0.030	102
the absence of shame and guilt in your life	0.07	0.016	104	0.00	0.025	107
you having a beautiful life story, or a life that is "like a work of art"	0.07	0.016	105	0.13	0.034	84
the absence of humiliation and embarrassment in your life	0.07	0.016	106	0.07	0.025	99
you having others remember you and your accomplishments long after your death	0.04	0.022	106a			
your ability to "be in the moment"	0.04	0.017	107	-0.02	0.023	108
your enjoyment of winning, competing, and facing challenges	0.04	0.016	108	0.02	0.024	104
how high your income is compared to the income of other people around you	0.03	0.022	108a			
your social status	-0.06	0.022	108b			
your power over other people	-0.09	0.022	108c			

Notes: Personal panel: OLS regression of stated preference on 113 personal aspects and a constant (const. = 0.02, s.e. = 0.003), using personal choice scenarios ($N=50,688$). Policy panel: OLS regression of stated preference on the 131 policy aspects and a constant (const. = 0.01, s.e. = 0.004) using the policy vote scenarios ($N=23,040$). Standard errors clustered at the respondent level. For the 108 aspects that have versions that appear in both types of scenarios, the text used in the personal choice scenarios is shown; in policy choice scenarios, "people" and "people's" replace "you" and "your." For each scenario type, the numbers 1108 are used to rank, by coefficient size, aspects that appear in both scenario types. An aspect that appears in one scenario type receives a rank with a letter: 5a, for example, indicates that the coefficient was between the aspects ranked 5 and 6.

We interpret the regression 3.3 as estimating equation 3.2, where in our empirical analysis, $\Delta \mathbf{w}$ is the difference in aspect ratings across the two options in a scenario. The β vector estimates a vector proportional to $D_w u(\mathbf{w})$, and ε_s captures response error. We interpret α , which we estimate to be 0.02 (s.e. = 0.003), as picking up a very small respondent bias in favor of "Option 1" despite the fact that the content of the two options is randomly drawn from the same distribution.

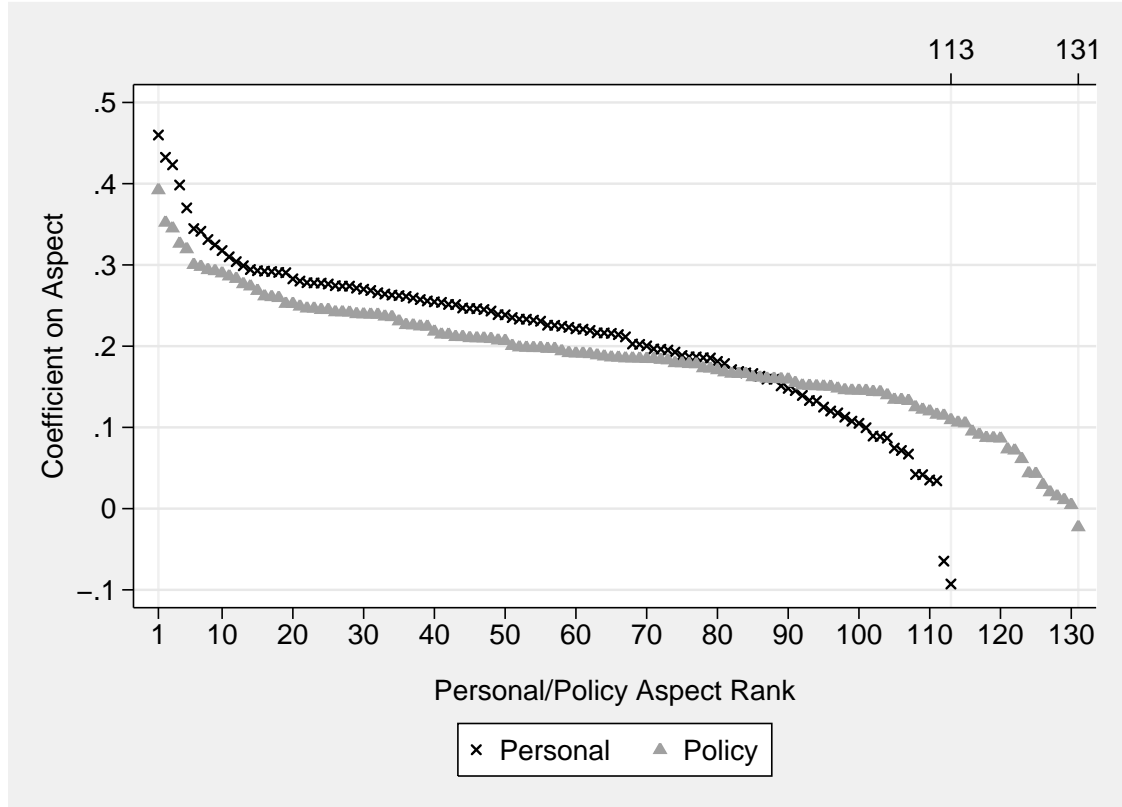
The Personal panel in Table 3.2 reports, for each of the 113 aspect regressors, its coefficient and standard error. The "Rank" column orders the *you*-aspects by coefficient size (1-108) and, additionally, places the 5 *you-only*-aspects relative to these by assigning to them rank numbers with letter suffixes (e.g., "74a" lies between 74 and 75).²¹ Since the independent and dependent variables are coded over ranges of the same length (1 to +1), a coefficient of, for example, +0.46 means that on average, changing the relevant aspect from the extreme rating "Option 1 much higher" to the other extreme of "Option 2 much higher" causes choice to move 46 percent of the entire choice scale in the same direction.

Figure 3.3 summarizes the coefficient and rank information in Table 3.2 graphically, for the 113 personal aspects (x's) and the 131 policy aspects (triangles; we discuss these below), sorted by their respective within-panel rank. Of the 113 personal aspects, all but two are positive, almost all statistically significantly so. This confirms that, as intended by our wording of the aspects, an option rating higher on an aspect is, *ceteris paribus*, generally considered preferable. (We discuss the two coefficients that are negative below.) The table and the figure show that the greatest variation in coefficient size across aspects occurs among those at the top (for example, the top 10 coefficients range from +0.46 to +0.32), and at the bottom (the bottom 10 range from +0.09 to 0.09); coefficients vary more slowly among middle-ranking aspects. The standard errors

²¹

This ranking scheme facilitates comparing the 108 *you*-aspect ranks with their corresponding 108 *everyone*-aspect ranks in the "Policy" panel, accommodating the fact that the *you-only*-aspects do not have counterparts in policy scenarios (and, similarly, that the *public*-aspects do not have counterparts in the "Personal" panel).

Figure 3.3: Relative Marginal Utility Estimates



Notes: Aspect coefficients by rank, from benchmark OLS regressions (table 3.2), separately for 113 personal-scenario aspects (x's) and 131 policy-scenario aspects (triangles).

on the coefficients are typically below 0.017. These features of our estimates should be borne in mind when reading our discussion below, which focuses on ranks.

Looking at specific aspects, those involving family (well-being [rank 1], happiness [2], and relationship quality [5]); health (general [3] and mental [7]); security (financial [6], about life and the future [8], and physical [21]); values (morality [4] and meaning [10]); and options (freedom of choice [9] and resources [12]) are conspicuous in their predominance at the top of the table, along with—reassuringly—some measures of happiness and life satisfaction (these are

discussed below). In contrast, at the very bottom of the table, we find all four *you-only* aspects that involve relative position–power over other people [108c], social status [108b], high relative income [108a], and postmortem fame [106a]–with coefficients that are either negative or close to zero.²² Since much evidence seems to imply a *high* marginal utility to status and relative position (see Heffetz and Frank 2011, for a survey), we conjecture that the low ranks of these aspects may reflect respondents’ answering our stated-preference question in terms of their meta-preferences or laundered preferences.²³

While as noted above we do not view the potential for meta- or laundered preference elicitation as necessarily a disadvantage, our estimates may also be sensitive to specific details of our survey design and the underlying respondent population. Later in this and the next section, we compare estimates based on alternative design details and on alternative subpopulations. Since our general method is held fixed, however, we can only speculate on its effect on our results. The deliberative frame of mind induced by our setup may make evaluative SWB aspects easier for respondents to consider than affective aspects; the double-negative framing of negative emotions may make them harder to think about than positive emotions; and the instruction to hold other aspects constant is almost certainly more difficult to follow when broader, combination aspects are varied in a scenario than when only narrow, fundamental aspects are varied. To the extent that our fixed design choices amplify estimated coefficients on some categories of aspects relative to others, comparisons of aspects *within* an aspect category may be more generalizable to alternative design choices than comparisons *across* categories. These caveats should be borne in mind through-

²²

The fifth *you-only*-aspect is non-positional: "the happiness of your friends" [74a]. At the same time, two of the other aspects at the bottom—"your enjoyment of winning, competing, and facing challenges" [108] and, to a lesser extent, a "ladder" aspect modeled after Cantril’s Self-Anchoring Scale [103]—could have been interpreted by respondents as involving relative position, although we did not perceive them that way when compiling our aspect list. Indeed, we expected the ladder aspect to rank high, along with other evaluative SWB measures (see Section 3.4.3 below).

²³

Another possibility is that the low rank of these aspects reflects experimenter-demand effects. While we cannot rule out this concern, we believe it is less likely in an anonymous web-survey like ours.

out our discussion below.

3.4.3 Personal Choices: Discussion

Evaluative and affective SWB.—Among happiness and life satisfaction measures, the more evaluative ones—family happiness²⁴ [2] and life satisfaction [11]—are among the highest-ranking aspects, and rank higher than the more affective ones—"how much of the time you feel happy" [31] and "how happy you feel" [39]. Other measures that past work has classified as positive affect measures, such as "how often you smile or laugh" [35] (e.g., Kahneman and Deaton, 2010), rank similarly to these affective happiness measures.

Negative emotions.—Recently, Deaton et al. (2011) suggest that national SWB surveys focus also on measuring negative emotions. In our data, the six measures they recommend (in their "rough order of preference") get the following ranks: pain [49], stress [45], worry [52], anger [76], tired (not on our list, but we have: feeling full of energy [42] and quality of sleep [77]), and sad [64]. This group of measures lies in the middle of our table, with coefficients in the range 0.19–0.25. Other negative emotions, such as frustration [67], are also in this range. Of particular interest because it is the only negative emotion among the four U.K. questions from the Introduction, anxious [92] lies somewhat *below* this range; its coefficient (0.13) is roughly half the coefficients of stress (0.25) and pain (0.24).

Eudaimonic SWB.—While evaluative and affective measures dominate the policy discourse on national SWB surveys, researchers increasingly recognize the importance of eudaimonic dimensions of well-being. In our data, eudaimonic

²⁴

If our respondents interpret our family happiness aspect [rank 2] as including self, then it is more inclusive than typical happiness measures (that refer only to self). As a result, we do not know if its place at the top of the table is due to it being a relatively evaluative happiness measure or to its inclusion of family. (We view this aspect as a relatively evaluative measure since reporting one's family happiness is likely to require more evaluative effort than reporting about one's own emotions.)

aspects such as being a good, moral person and living according to personal values [4] (coefficient 0.40) and having a life that is meaningful and has value [10] (coefficient 0.32) indeed rank among the highest aspects. The aspect modeled after the only eudaimonic question in the U.K. four–feeling that the things you do in your life are worthwhile [20]–has a reasonably high coefficient (0.28), yet lower than the two above.

In summary, our agnostic, stated-preference-based approach yields high marginal utility estimates on measures—such as life satisfaction—that have been at the center of the discussion about well-being indices. At the same time, other measures that have received recent attention—such as those of positive and negative affect, and certain eudaimonic measures—have coefficients that are not as high as aspects that have received less attention in this context, in particular, about family, health, security, values, and options. The two measures with the largest coefficients—"the overall well-being of you and your family" and "the happiness of your family"—are, as far as we know, survey questions we invented that have not previously been asked in large-scale surveys. Our results suggest they deserve attention in future data collection efforts.²⁵

3.4.4 Policy Choices

The "Policy" panel of Table 3.2 reports estimates from a specification identical to that used in the "Personal" panel but uses data from the five policy scenarios each respondent faced. Recall that in such scenarios, respondents vote on policy, trading off 131 aspects that include *everyone*-aspects (personal aspects that pertain to everyone in the nation) and *public*-aspects (public goods that pertain to the entire nation or, when stated, to the entire world). To make the coefficient magnitudes comparable across the two panels, we use the same numerical scales as in the personal regression (rather than reestimating them). As

²⁵

For example, to capture our overall top-ranked aspect, surveys could ask: "On a scale from zero to ten, how would you rate the overall well-being of you and your family?"

mentioned above, to further facilitate such comparison between the *you*-aspects and their corresponding *everyone*-aspects, the "Rank" column ranks the *everyone*-aspects by coefficient size (1-108) and, in addition, places the 23 *public*-aspects relative to these by assigning to them rank numbers with letter suffixes.

Since we collected less data in these policy scenarios than in personal scenarios, standard errors are larger, typically in the 0.023-0.035 range. Nonetheless, the correlation between the 108 *you*- and *everyone*-coefficient pairs is fairly high (0.81).²⁶ Figure 3.4 conveys the comparison graphically by replicating Figure 3.3 for only the 108 *you*- and 108 *everyone*-aspects, both sorted by the rank of the *you*-aspects in the personal scenarios. The dashed curve reports a locally-weighted linear regression of the *everyone*-coefficients (triangles). The figure suggests that on average, *everyone*-coefficients in the policy scenarios are attenuated versions of their counterpart *you*-coefficients in the personal scenarios. This may reflect respondents' greater uncertainty regarding others' preferences, perhaps causing respondents to state preferences with weaker intensity in policy scenarios (though remember that coefficient ratios are what matter for the index).

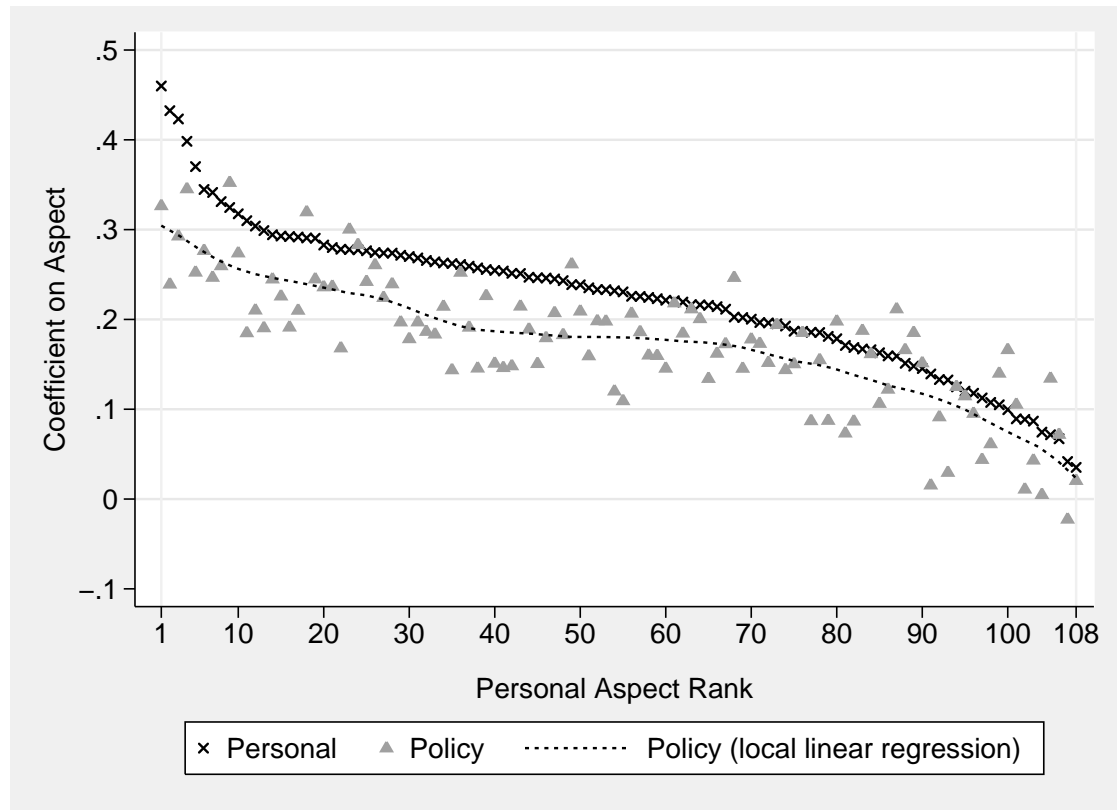
Consistent with the high correlation, some of the high-ranking *you*-aspects retain their high rank as *everyone*-aspects. These include overall well-being of you and your family [personal rank 1; policy rank 3], health [3; 6], personal values [4; 2], and financial security [6; 8]. At the same time, aspects related to freedom and to avoiding abuse seem to rank higher as policy aspects. These include the freedom to choose [9; 1]; your ability to pursue your dreams [36; 14]; being treated with dignity [26; 11]; and, among double negatives, avoiding deception [23; 5], pain [49; 10], and emotional abuse [68; 16].

Perhaps most importantly, several of the 23 *public*-aspects (included in the policy but not the personal scenarios) have among the largest coefficients. These include freedom from corruption, injustice, and abuse of power [0a] (coefficient

²⁶

Here and later, we report the correlation between two vectors of estimated (sample) coefficients. Due to sampling error, this reported correlation is a lower bound on the correlation between the vectors of true (population) coefficients.

Figure 3.4: Relative Marginal Utility Estimates: 108 *you*- and *everyone*-aspects



Notes: Aspect coefficients from benchmark OLS regressions (Table 3.2) for the 108 *you*-aspects (from personal scenarios, x's) and their corresponding 108 *everyone*-aspects (from policy scenarios, triangles), by rank in the personal scenarios. Dashed curve: local linear regression of *everyone*-coefficients (Epanechnikov kernel, bandwidth = 6).

0.39), society helping those who struggle [5a], the morality of other people [5b], freedom of speech and of political participation [6a], and the well-being of the people in your nation [6b].²⁷ High coefficients on freedom from corruption and freedom of speech seem consistent with the tendency for respondents to

²⁷

Note that the *public*-aspect "the well-being of people in your nation" [6b] is quite similar to the *everyone*-aspect "the well-being of people and their families" [3]. The higher rank of the latter is consistent with the idea that highlighting "families" may raise the perceived importance of an aspect.

weight heavily, in a policy context, aspects that expand individuals' choice sets—reducing the need to choose specific outcomes for others. We interpret these findings as providing empirical evidence that when making a policy choice, our respondents put high value on capabilities (Sen 1985) and basic rights (Rawls 1971).

Finally, we discuss "objective" aspects, some of which are modeled after widely-used indicators. As discussed above, some of these aspects have large coefficients, including freedom from corruption, injustice, and abuse of power; financial security; health; and freedom of speech and of political participation. But among standard macroeconomic indicators, only low unemployment [18a] has a relatively high rank. Others have lower ranks: low inflation [43a], GDP growth [57a], GDP per capita [61a], and GDP [88a]. The tendency to prefer aspects that increase the choice set (rather than focusing exclusively on outcomes) may help explain why, among the "objective" aspects, the coefficient on equality of opportunity [19b] is relatively large (0.24), larger, for example, than that on equality of income [66a] (0.16).

3.4.5 Cross-Group Heterogeneity

To provide some evidence on cross-group differences in marginal utilities, we estimated equation 3.3 using subpopulations of our respondents: men and women; those above and below an income of \$50,000/year; liberals, moderates and conservatives; those who do and do not attend religious services at least monthly; and those younger and older than 45. Results of this analysis are available through the authors. Here, we briefly summarize only some of the main findings that emerge.

Overall, aspects in the personal scenarios rank similarly across the subpopulations we examine. The sets of 113 coefficients are highly correlated across pairs of disjoint groups, with correlations ranging from 0.86 (liberals vs. moderates) to 0.91 (men vs. women). Moreover, there seems to be a broad consensus

across the subpopulations that the highest-ranking aspects include those related to family, health, and security.

To explore which aspects' coefficients change most dramatically across groups, we first normalize our marginal utility estimates to comparable units across groups by dividing each groups set of 113 coefficients by its mean (effectively treating the "average aspect" as numeraire); we then examine, for each aspect and each pair of disjoint groups, the ratio of the two normalized coefficients, dividing the smaller coefficient by the larger (so all ratios are ≤ 1). We highlight here aspects that rank in the top ten in one group but drop sufficiently in the complementary group to yield a ratio of less than 0.8. We caution that not only our estimates in Table 3.2, but also these cross-group differences, may not generalize to a more representative sample (cf., Hefetz and Rabin 2013).

Men rank higher: "your sense that your life is meaningful and has value" [men rank 5, women rank 29, normalized coefficient ratio (cr) = 0.77]. **Women rank higher:** "your mental health and emotional stability" [women 6, men 23, cr = 0.71].

High-income rank higher: life satisfaction [high income 5, low income 41, cr = 0.70], and having a meaningful life [high 7, low 24, cr = 0.75].

Liberals rank higher: having enough time and money [liberals 4, conservatives 30, cr = 0.78]. **Conservatives rank higher:** being a good, moral person and living according to personal values [co. 4, li. 6, cr = 0.75], family happiness [co. 1, li. 3, cr = 0.75], and family relationships [co. 5, li. 9, cr = 0.77].

More religious rank higher: sense of purpose [more religious 9, less religious 72, cr = 0.60], having people around you who share your values, beliefs and interests [more 10, less 60, cr = 0.69], feeling grateful [more 8, less 50, cr = 0.74], being good and moral [more 2, less 7, cr = 0.74], and making a difference and making the world a better place [more 7, less 35, cr = 0.76]. **Less religious rank higher:** life satisfaction [less 9, more 36, cr = 0.77].

Older rank higher: having many options and possibilities in life and the

freedom to choose among them [older 5, younger 35, $cr = 0.65$].

In policy scenarios, correlations between pairs of sets of the 131 coefficients are lower—although still reasonably high—and range from 0.60 (liberals versus conservatives) to 0.81 (more versus less religious). All ratios are calculated using the same method as above. Here we highlight aspects with normalized ratios below 0.6. **Women rank higher:** "people being good, moral people" [women 1, men 35, $cr = 0.50$]. **Men rank higher:** "people getting the rewards and punishments they deserve" [men 5, women 75, $cr = 0.58$]. **Liberals rank higher:** the condition of animals, nature, and the environment [li. 1, co. 113, $cr = 0.27$]. **Conservatives rank higher:** "people's ability to have and raise children" [co. 8, li. 111, $cr = 0.33$]. **Older rank higher:** being treated with dignity and respect [older 6, younger 76, $cr = 0.53$].

3.5 Robustness and Additional Results

In the previous section we reported results: from (i) a simple OLS specification; including (ii) our entire personal and policy aspect lists; and pooling responses (iii) across scenarios with different numbers of aspects, (iv) across all but the speediest-to-answer respondents, and (v) across scenarios faced earlier and later in the survey. In this section, we briefly revisit these points, summarizing analyses reported in more detail in tables available through the authors.

(i) *Econometric Specification.*—In our OLS specification we coded the verbal scales of the independent and dependent variables as exogenously imposed numeric scales. These were estimated from the following nonlinear ordered probit specification:

$$\text{StatedPreference}_s^* = \left(\text{Option}_s \circ \left[\gamma_{\text{slightly}} \mathbf{1}_{\{\text{slightly}\},s} + \gamma_{\text{somewhat}} \mathbf{1}_{\{\text{somewhat}\},s} + \mathbf{1}_{\{\text{much}\},s} \right] \right)' \cdot \boldsymbol{\beta} + \varepsilon_s$$

$\text{StatedPreference}_s^*$ is the latent dependent variable; Option_s , $\mathbf{1}_{\{\text{slightly}\},s}$, $\mathbf{1}_{\{\text{somewhat}\},s}$,

and $\mathbf{1}_{\{much\},s}$ are vectors (whose length is the number of aspects) that jointly encode the differences between the two options; and \circ is the entry-wise vector product. Each entry of \mathbf{Option}_s is equal to 1, +1, or 0, depending on whether the aspect table rates that aspect higher on Option 1, Option 2, or neither. The entries of $\mathbf{1}_{\{slightly\},s}$, $\mathbf{1}_{\{somewhat\},s}$, and $\mathbf{1}_{\{much\},s}$ are indicators of whether the aspect is rated slightly, somewhat, or much higher. We assume that ε_s is normally distributed and use maximum likelihood to estimate the parameters: $\gamma_{slightly}$, $\gamma_{somewhat}$, the coefficient vector β , and the five cutpoints that link $\text{StatedPreference}_s^*$ to the observed choice, $\text{StatedPreference}_s$.

Note that specification 3.4 normalizes "much" to be 1 or +1 depending on whether it favors Option 1 or Option 2, and the numerical values for "slightly" and "somewhat" used for the OLS specification in Section 3.4 are $\hat{\gamma}_{slightly}$ and $\hat{\gamma}_{somewhat}$. The resulting aspects-rating scale (i.e., the values of $\hat{\gamma}_{slightly}$ and $\hat{\gamma}_{somewhat}$) is determined by the extent to which the verbal labels affect choice differently, which in turn depends on a combination of three factors: (i) respondents' quantitative interpretations of the verbal labels (namely, the magnitudes on the x -axis that correspond to "slightly" and "somewhat," given that "much" is normalized to 1); (ii) higher derivatives of utility, averaged across the aspects (i.e., how utility on the y -axis depends on the x -axis magnitudes); and (iii) any "focusing effect," that is, respondents paying less attention to an aspect's rating than to its direction in favor of one of the options.

To obtain values for the choice scale in the OLS specification, we use the standard normal cdf to calculate the expected value of latent preference intensity conditional on observed preference-intensity category; linearly rescale these conditional expectations to lie in the (1, +1) interval; and symmetrize them around zero by taking the average of the absolute value of each pair of corresponding conditional expectations. The resulting choice scale captures respondents quantitative interpretations of the verbal choice labels.

Not surprisingly, since the numerical scales in the OLS regressions reported in Section 3.4 are estimated from the nonlinear ordered probit, the correlations

between the 113 personal β 's estimated using equations 3.3 and 3.4, as well as between the 131 policy β 's across specifications, are virtually 1. As an alternative, re-estimating the OLS regressions in Table 3.2 using linear scales as described in Section 3.4.2 yields personal and policy coefficients whose correlations with those in Table 3.2 are above 0.99. As a variant that allows respondents to differ in their interpretation of the choice intensities, we first normalize the choice scale at the respondent level by stretching the linear scale so that the variance across each respondent's 30 choices is 1, and only then estimate the OLS. The correlations between the coefficients estimated with and without this normalization are at least 0.98. Probit and logit models yield very similar results.

(ii) *Fundamental and Combination Aspects.*—If a combination and a fundamental aspect appear in the same scenario, then the presence of the combination aspect might affect respondents' interpretation of the fundamental aspect. For example, if "the overall well-being of you and your family" is a function of "your family's happiness," then a respondent asked to trade them off might—contrary to our intention—interpret the former as meaning overall well-being exclusive of family happiness. Depending on the prevalence of such situations and on how respondents interpret them, our estimated coefficients might be biased.

To probe the robustness of our results to this potential concern, we reestimate our benchmark OLS model leaving out scenarios containing aspects that seem most likely to be functions of other aspects on our list. For example, for personal choices we exclude all aspects that we view as evaluative SWB measures—including both commonly used ones (e.g., life satisfaction) and our novel proposals (e.g., how desirable your life is).²⁸ The estimated coefficients on the 94 remaining aspects are broadly similar to those reported in Table 3.2 (correlation 0.99). Results are similar in other specifications, for example, excluding the macroeconomic indicators in policy vote scenarios.

(iii) *Number of Aspects per Scenario.*—As explained in Section 3.3.1, respon-

28

As our data and code are available on the journal's and our websites, an interested reader can readily re-estimate our model using her or his preferred subset of aspects.

dents face two-, three-, four-, and six-aspect scenarios. Reestimating our OLS model separately for each of these four scenario designs, we find that the range of coefficient sizes roughly halves from two- to six-aspect scenarios. The correlations between the four sets of 113 and of 131 coefficients range from 0.84 to 0.92 in personal and from 0.52 to 0.70 in policy scenarios (but note that the latter are more attenuated because the policy coefficients estimation errors are larger). We also examine, for each pair of coefficient sets, the intercept of the SD line (the line going through the mean of the sets whose slope is the ratio of standard deviations). If one set were identical to another up to a multiplicative scalar—i.e., the two sets implied identical marginal rates of substitution—the intercept would be zero. We find that the intercepts are close to zero, ranging from 0.04 to 0.15 in personal and from 0.10 to 0.10 in policy scenarios. Our general conclusion is that while respondents allow each aspect to influence their stated preference less intensely *per aspect* when the number of aspects is larger, relative coefficient size remains rather stable in personal scenarios and somewhat stable in policy scenarios.

(iv) *Respondents' Effort and Comprehension.*—Respondents may exert little effort on unincentivized surveys. This may bias the estimated coefficients away from the true marginal utilities, for example by "compressing" aspects' coefficients toward each other if respondents pay less attention to each aspect's identity, or by biasing coefficients toward zero if respondents answer randomly. Using amount of time to complete the survey as a proxy for effort level, and reestimating our main OLS specification separately by approximate sextiles, we indeed find that the coefficients of the speediest sextile (less than eight minutes) are severely attenuated relative to other sextiles' coefficients. Outside the speediest sextile, coefficient sizes seem to increase with completion-time sextile less steeply and then peak at the second-slowest sextile (2131 minutes). Furthermore, the correlations between the personal coefficients of the speediest sextile and of other sextiles range from 0.23 to 0.32, much lower than the correlations between pairs of other sextiles' coefficient sets, which range from 0.76 to 0.89. For these reasons, our benchmark OLS specification reported in Table 3.2 ex-

cludes respondents who took less than eight minutes to complete the survey.²⁹ Further excluding those who reported in the exit questionnaire that they did "not really" understand what they were asked to do (see Section 3.3.2 above) yields virtually identical estimates.

(v) *Early vs. Late Scenarios.*—Responses made later in the survey may be less reliable due to tiredness or boredom. Alternatively, they may be *more* reliable due to practice. Also, respondents' interpretations of particular aspects may change over the course of the survey. For example, respondents may interpret life satisfaction as a broad SWB measure early on, but as they face new examples of affective SWB measures, they may interpret it to exclude feelings.

To assess these possibilities, we estimate an augmented version of our OLS specification by including a dummy for whether a scenario appeared in the earlier half of the survey and interacting it with each aspect's rating. We find no evidence of systematic differences between estimates from scenarios in earlier and later halves of the survey.

3.6 Pragmatics

We now return to the two practical issues we posed in the introduction: which questions should a SWB survey ask, and how should the responses be weighted? In theory, the well-being index formula, $\sum_{j=1}^J \frac{\partial u(\mathbf{w})}{\partial w_j} w_j$, provides clear solutions: ask about the levels of each of the J fundamental aspects comprising \mathbf{w} , and weight the responses by their marginal utilities. In practice, as we have emphasized throughout, both our proposed list of fundamental aspects and our marginal-utility estimates are only first-pass proofs-of-concept in need

29

As an additional respondent-effort sensitivity check, we examine respondents who, in at least one three-aspect scenario where one option happens to rate higher on all three aspects, choose the other option. The rankings of aspects in this sample are similar to our benchmark, but the coefficients are greatly attenuated. We like this sensitivity check less because it may fail to drop random responders (who choose the higher-rated option by chance) and, at the same time, may unduly drop respondents who prefer *less* of certain aspects.

of further development.

In conjunction with making progress on those fronts, governments that wish to construct reliable well-being indices will have to overcome additional challenges that we have deferred until now. In this section we return to these challenges and outline directions for surmounting them.

3.6.1 Overlapping Questions

In our theory in Section 3.1, preferences are defined over a vector \mathbf{w} of fundamental aspects. While further progress on extending our list of survey questions may eventually result in an exhaustive list that includes *all* the components of \mathbf{w} (as required by the theory), it would likely also further increase the incidence of conceptually overlapping questions (which the theory assumes away). Note that conceptual overlap between questions is different from empirical *covariance* (e.g., in the time series) between questions: while overlap exists when two or more questions refer, by the meaning of the language they use, to some of the same fundamental aspects (an extreme example: two questions that are perfectly synonymous), covariance between questions is a feature of the empirical joint distribution of aspect levels (an extreme example: two conceptually distinct measures A and B that are perfectly correlated, say, due to A causing B). Hence non-zero covariances are likely even in the absence of overlap, and information regarding covariances across SWB survey waves (or across respondents) is not sufficient for identifying overlap.

Intuitively, including overlapping questions in the well-being index would lead to double-counting, a problem analogous to counting some components of GDP more than once. Hence, before a reliable well-being index can be constructed, a strategy is needed for avoiding double-counting. One such strategy is to find a list of SWB questions free from overlap by eliminating questions that overlap with other questions on the list. Doing so requires a method for detecting overlap between any given pair of SWB survey questions. This subsection

briefly outlines the basic idea underlying one such method; we provide an extended discussion, a fully specified concrete example, and a formal treatment in Appendix section C.4.

The idea behind our overlap-detection method is to use a variation on our SP survey in order to compare the (relative) marginal utility of the *joint* increase in two survey questions (appearing within a single scenario option) with the sum of the (relative) marginal utilities of the *separate* increases of the two survey questions (appearing in two separate scenarios). For example, consider two of the UK questions from the introduction: life satisfaction and life worthwhileness. If the two questions do not overlap—that is, if they elicit two fundamental aspects or, more generally, two functions of disjoint sets of fundamental aspects—then the sum of the marginal utility of life satisfaction plus the marginal utility of life worthwhileness (both relative, say, to the marginal utility of health) would equal the (relative to health) marginal utility of a joint increase in life satisfaction and life worthwhileness. This equality holds approximately even if the aspects measured by the two questions enter preferences as complements, as long as the increases are small. On the other hand, if the two questions do overlap, then the marginal utility of their joint increase would be smaller than the sum of marginal utilities of their separate increases because part of the joint increase is overlapping and is taken into account by survey respondents only once.

Therefore, to identify overlap between, e.g., life satisfaction and life worthwhileness, in the Appendix we propose to measure these (relative) marginal utilities by collecting data from (i) two-aspect scenarios where respondents choose between different increases in life satisfaction in Option 1 versus increases in a third aspect in Option 2; (ii) two-aspect scenarios where respondents choose between different increases in life worthwhileness in Option 1 versus increases in that third aspect in Option 2; and (iii) three-aspect scenarios where respondents choose between different increases in life satisfaction *and* life worthwhileness in Option 1 versus increases in that third aspect in Option 2. Such a data collection effort would effectively replicate our own SP survey, with three

main differences: first, it would target pairs of questions where overlap is suspected; second, it would involve only the relevant two- and three-aspect scenarios described in (i), (ii), and (iii) above; and third, it would adjust and refine the language in the scenarios' preamble to encourage respondents to interpret joint increases in pairs of questions in specific ways, a point that we briefly discuss now.

While our SP-survey instructions may be sufficient when the SWB survey questions under study are fundamental aspects, the formal theory we develop in the Appendix highlights the importance of respondents' interpretation of the implied changes in fundamental aspects when the questions under study are not themselves one-to-one measures of fundamental aspects. We present two propositions, relying on two alternative sets of assumptions regarding respondents' interpretations, each of which formally substantiates the validity of our overlap-detection method. However, as we discuss in the Appendix, developing the survey language that would encourage respondents to interpret scenarios in one of the ways required by our theory would necessitate a process of developing and testing survey instructions that goes beyond the scope of this paper. Nevertheless, our appendix treatment suggests that the problem of potential question overlap can be analyzed formally and addressed practically, and takes some tentative steps in those directions.

3.6.2 Abridged Index

From a pragmatic point of view, identifying a sub-list of survey questions that avoids overlap (while fully covering the fundamental aspects in \mathbf{w}) has an additional important consequence: it shortens the list of questions to elicit. In what follows, we use the term "full index" to refer to the well-being index that is based on such a shorter yet complete list, which we assume consists of exactly J fundamental-aspect questions.³⁰ Such a list may still however be longer than

30

the list of questions a governments is able (or willing) to regularly include on each wave of its SWB survey. It may hence be important to also consider the two practical questions from the introduction with an added constraint: which items should a government include on a SWB survey that is limited to only $N < J$ questions? And, conditional on asking N questions (not necessarily the optimal ones), how should the responses be weighted?

Conditional on a SWB survey eliciting responses $\{r_1, r_2, \dots, r_N\}$ to a given set of N questions, a natural weighting approach is to seek weights, $\alpha_1, \alpha_2, \dots, \alpha_N$, such that the "abridged index" $\sum_{n=1}^N \alpha_n r_n$ is the best predictor of the full index in an R^2 sense. The optimal weights will generally no longer be proportional to the estimated marginal utilities because included questions will proxy for excluded aspects with which they covary in the time series.³¹ If, in addition, the N questions can be selected, then a natural selection approach is to select those that, weighted optimally, best predict the time series of the full index. (Combination-aspect questions that have been excluded from the full index due to overlap may be especially useful in this context.) Note that the optimal set of N questions may not necessarily include the questions with the largest marginal-utility estimates. For example, Deaton et al. (2011) argue that negative emotions (whose coefficients we report in Section 3.4.3 above as ranking only in the middle of our Table 3.2) are important to include on a government's SWB survey due to their relatively high variance and low covariance with other questions.

To construct an N -question abridged index that is optimal in the above sense of best-predicting the full index, it would be necessary to first construct and track the full index, at least for a few survey waves. In the theoretically ideal world of an infinite sample and unlimited computing power, the opti-

With J fundamental aspects in \mathbf{w} , a complete no-overlap list has at most J questions: exactly J if they are all fundamental-aspect questions, or fewer if some are "composite-aspect" questions, meaning that they elicit non-fundamental aspects that are subutility functions (see the Appendix for a formal definition and discussion). Such composite aspects can be substituted in the theory and in the index for their underlying fundamental aspects.

³¹

Note that variants of our SP survey (including those referred to in Section 3.6.1) are not informative regarding covariances because the SP survey exogenously varies the aspect bundles to be compared in a way unrelated to time-series covariances of responses to the SWB survey.

mal abridged index would be found by regressing the full index on all possible sets of N questions, finding the set that maximizes R^2 . In practice, with a finite sample, more sophisticated methods are needed to avoid overfitting in both selection of questions and estimation of their coefficients. Miller (2002) provides a comprehensive discussion of such methods.

Two additional points regarding an abridged index are worth mentioning. First, different abridged indices may be optimal for different intended uses of the index. For example, if the abridged index is used mainly to track individuals' well-being over time, then the objective function to best-predict is a time-series of the full index (as proposed above). Alternatively, if the index is used to guide policy, then question selection and weighting should account for the fact that some aspects may vary a great deal but be relatively immune to policy, while others may move little unless changed by policy (for example, Deaton et al. (2011) argue that stress may be particularly sensitive to policy).

Second, if the questions' variance-covariance matrix shifts over time, then an abridged index's optimal questions and weights may change even when the intended use is held fixed and even if the marginal utilities have not changed. This point is related to the well-known Lucas critique from macroeconomics; even if the underlying structural model is fixed, the best-fitting reduced-form equation may be unstable as circumstances shift. For this reason, the full index should be tracked at least periodically—e.g., by switching back, every few survey waves, from the abridged survey to the full survey—and the optimal abridged index should be periodically re-estimated.

3.6.3 Pooling Respondents

While abridged indices would reduce the number of questions to ask on regular SWB-survey waves, our discussion above makes it clear that at least periodically, it is crucial to construct the full index. Hence, at least periodically, the full list of SWB questions *and* a full set of marginal-utility estimates would be

needed. Even if the full list of SWB questions is not by itself considered too long to ask on a single *SWB* survey, multiple *SP*-survey questions are required for estimating each marginal utility, and therefore estimating the full set of marginal utilities may require a long survey. While breaking a long survey into shorter modules administered to the same respondent on successive occasions may be feasible, a government might wish to divide the full set of required *SP* questions across different respondents and pool their responses. Under what conditions would doing so be justified?

Our theory in Section 3.1 is restricted to an individual agent. Estimating marginal utilities from pooled data is therefore theoretically justified only when the pooled respondents' indifference surfaces have the same local slope. We refer to such respondents as being of the same "type."³² In practice, while it is unlikely that any two respondents are of exactly the same type, it may be possible to partition a population of respondents into approximate types. To do so, one would need to conduct a full *SP* survey (long enough for identifying each respondents local marginal utilities) on at least a subsample of respondents. One could then search for observables (such as sex, age, etc.) that may characterize types.

In our own main specification in Section 3.4, we pooled data across all of our respondents, effectively treating them all as a single type. Doing so is difficult to justify theoretically, and as discussed above governments should not—and would not have to—do so. That said, to the extent that some of our estimates by several different demographic groups (summarized in Section 3.4.5) are viewed as not that different from each other, it is possible that, as an empirical matter, pooling may yield sensible estimates.

³²

Thus, even if two respondents have the same preferences, if their interpretation and reporting of their w 's differ in a way that leads to indifference surfaces with different local slopes, then the respondents should be considered of different types. On the other hand, even if two respondents interpret an aspect differently—for example, "being a good, moral person" could involve different behaviors that satisfy different moral values for different people—the two are still of the same type as long as that aspects relative marginal utility is the same at their current fundamental-aspect levels.

3.7 Concluding Remarks

Our current system of national accounts has been continually refined over many decades, and continues to be revised. Converging on how well-being should be tracked is likely to be similarly arduous. Much work has already been done. But that work, and our own contributions—the theory and methodology, aspect list, and marginal-utility estimates—are only a bare beginning. We address only a fraction of the issues in constructing well-being indices that we are aware of, and there are surely many other issues we have not thought of.

Perhaps the most urgent unresolved theoretical issue is aggregation across individuals. This issue is not specific to our approach. As a workaround, researchers (say, using aggregate consumption or GDP as a welfare measure) often take the leap of assuming a representative agent. If one were willing to assume a representative agent, a national well-being index could be constructed from marginal-utility estimates like ours, together with average responses to a SWB survey. Alternatively, including money in the SP survey as if it were an "aspect" would enable scaling the marginal utilities in dollar units (see footnote 14). The change in the well-being index could then be measured in dollars for each respondent and summed across respondents. As another alternative, the same procedure could be followed with some other numeraire good; for example, time might be an attractive numeraire. Other recent proposals regarding aggregation in the context of SWB surveys include Fleurbaey, Schokkaert, and Decancq (2009), Fleurbaey and Maniquet (2011), and Benjamin, Heffetz, Kimball, and Szembrot (2013).

Another set of concerns, emphasized by Frey and Stutzer (2007, 2012), hereafter FS, is that if aggregated SWB responses were regularly used for policymaking, both governments and individuals might have an incentive to manipulate the survey-based index for their own benefit. One concern FS raise is that politicians and public officials have many degrees of freedom that they may exploit when selecting questions, weights, and the respondent population used for constructing an index. As FS observe, similar concerns also arise with traditional

indicators such as GDP and the rate of unemployment. We believe that—as with these traditional and widely-used indicators—having standardized procedures for constructing the index, such as the procedures developed in this paper, can eliminate many of these degrees of freedom. Another concern FS raise is that individuals may have an incentive to deviate from truthfully responding to the SWB survey. While we are not aware of evidence of such conscious attempts by individuals or interest groups to manipulate existing survey-based indicators such as the rate of unemployment, we explore in a companion paper (Benjamin, Heffetz, Kimball, and Szembrot 2013) a mechanism for aggregating SWB responses and guiding policy that reduces incentives for non-truthful responding.

Yet another set of concerns relates to measurement. While we have assumed throughout that aspects of well-being can be meaningfully measured with a SWB survey, such measurement still faces major challenges that we have not addressed. For example, traditional SWB measures may be over-sensitive to immediate context, under-sensitive to lasting changes in life circumstances, and subject to recalibration of the response scale (see Adler, 2013, for a comprehensive critical review of these and other challenges). And of course *all* survey measures are subject to measurement error.

We have focused on constructing a well-being index based on combining a SWB survey with a SP survey. But the framework and method we have developed could be applied in three additional directions. First, as mentioned above, one could use a SP survey to obtain weights for existing indices of objective measures, such as the Human Development Index (HDI), that currently use ad hoc weights. In that case, the objective measures—for the HDI: longevity, education, and GDP per capita—would replace the aspects in the SP survey.

Second, one could extend market-price-based indices, such as GDP, to incorporate other factors using "price" imputations. Rather than a function of fundamental aspects, utility would be modeled as a function of market goods as well as non-market goods such as leisure, social relationships, and the environment.

These goods would replace the aspects in the SP survey.

Third, while our SP survey and analysis are based on the assumption that respondents' stated preferences can be used to assess welfare—an approach we find attractive on liberalist grounds—our methodology could be adapted to accommodate alternative assumptions. For example, if one assumed that life satisfaction equaled welfare, then one would replace our stated choice question with a predicted-life-satisfaction question. Alternatively, one might replace "you" with "someone like you" in the stated-choice question if one believed that the latter would yield more reliable responses.

While we view this paper primarily as proposing a long-term agenda, our findings also point to a few readily actionable steps. First, our results suggest prioritizing the measurement of aspects related to family, health, and security; eudaimonic and especially evaluative SWB measures; and, especially in the policy context, freedoms and capabilities. Second, as discussed in Section 3.6, for the purpose of selecting specific questions for regular inclusion on SWB surveys, we highlight the value of gathering data on as many aspects as possible—at least initially (cf. Deaton et al. 2011) and at regular intervals. Third, along with conducting SWB surveys, we call for governments and researchers to devote resources to estimating aspects' marginal utilities; our SP survey illustrates one method for doing so.

APPENDIX A
APPENDIX TO CHAPTER 1

A.1 Proofs for Theoretical Results

A.1.1 Announcement Game

Lemma 1. Suppose that in equilibrium, only candidates who prefer A/E choose to take no position. Then,

1. A Bayesian voter believes the following about a candidate who takes no position:

$$\begin{aligned}\pi_{A|\emptyset} &= \frac{\pi_A}{1 - \gamma(1 - \pi_A)} \\ \pi_{B|\emptyset} &= \frac{(1 - \gamma)\pi_B}{1 - \gamma(1 - \pi_A)} \\ \pi_{C|\emptyset} &= \frac{(1 - \gamma)\pi_C}{1 - \gamma(1 - \pi_A)}\end{aligned}$$

In the limit as $\gamma \rightarrow 1$:

$$\begin{aligned}\pi_{A|\emptyset} &= 1 \\ \pi_{B|\emptyset} &= 0 \\ \pi_{C|\emptyset} &= 0\end{aligned}$$

2. A cursed voter believes the following about a candidate who takes no position:

$$\begin{aligned}\tilde{\pi}_{A|\emptyset} &= \frac{\pi_A [1 - \chi\gamma(1 - \pi_A)]}{1 - \gamma(1 - \pi_A)} \\ \tilde{\pi}_{B|\emptyset} &= \frac{\pi_B [1 - \gamma(1 - \chi\pi_A)]}{1 - \gamma(1 - \pi_A)}\end{aligned}$$

$$\tilde{\pi}_{C|\emptyset} = \frac{\pi_C [1 - \gamma (1 - \chi \pi_A)]}{1 - \gamma (1 - \pi_A)}$$

In the limit as $\gamma \rightarrow 1$:

$$\tilde{\pi}_{A|\emptyset} = 1 - \chi (1 - \pi_A)$$

$$\tilde{\pi}_{B|\emptyset} = \chi \pi_B$$

$$\tilde{\pi}_{C|\emptyset} = \chi \pi_C$$

Proof. Given the candidates' equilibrium strategies, Bayes' Rule implies that

$$\begin{aligned}\pi_{A|\emptyset} &= \frac{\pi_A}{\pi_A + (1 - \gamma)(1 - \pi_A)} \\ \pi_{B|\emptyset} &= \frac{(1 - \gamma)\pi_B}{\pi_A + (1 - \gamma)(1 - \pi_A)} \\ \pi_{C|\emptyset} &= \frac{(1 - \gamma)\pi_C}{\pi_A + (1 - \gamma)(1 - \pi_A)}\end{aligned}$$

By definition of cursed equilibrium,

$$\begin{aligned}\tilde{\pi}_{A|\emptyset} &= \chi \pi_A + \frac{(1 - \chi)\pi_A}{\pi_A + (1 - \gamma)(1 - \pi_A)} \\ \tilde{\pi}_{B|\emptyset} &= \chi \pi_B + \frac{(1 - \chi)(1 - \gamma)\pi_B}{\pi_A + (1 - \gamma)(1 - \pi_A)} \\ \tilde{\pi}_{C|\emptyset} &= \chi \pi_C + \frac{(1 - \chi)(1 - \gamma)\pi_C}{\pi_A + (1 - \gamma)(1 - \pi_A)}\end{aligned}$$

Simplification gives the beliefs listed in the statement of the Lemma. \square

Proposition 1. In the limit as $\gamma \rightarrow 1$, the near-revelation equilibrium exists as a Bayes-Nash equilibrium. **Proposition 2.** As $\gamma \rightarrow 1$, the near-revelation equilibrium exists as a cursed equilibrium if and only if

$$\chi \leq \chi_{NR} \equiv \frac{u_2 - u_3}{(1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2)} \quad (\text{A.1})$$

Proof. Suppose that the near-revelation equilibrium exists. Since candidates

who prefer A/E and C can do no better than following their equilibrium strategies, consider the decision of a candidate who prefers B/D. If he could defeat a opponent who revealed B/D by taking no position, then he would deviate, as doing so would improve his chance of beating A/E candidates and B/D candidates while not affecting his chances against C candidates. On the other hand, no candidate would deviate if voters supported a candidate who revealed B/D over one who took no position. The voter would vote for a candidate who revealed B/D if the opponent took no position if and only if $u_2 \geq \tilde{\pi}_{A|\emptyset}u_3 + \tilde{\pi}_{B|\emptyset}u_2 + \tilde{\pi}_{C|\emptyset}u_1$.

Substituting the beliefs derived in Lemma 1 into the inequality above gives

$$\begin{aligned}
u_2 &\geq \frac{\pi_A [1 - \chi\gamma(1 - \pi_A)]}{1 - \gamma(1 - \pi_A)}u_3 + \frac{\pi_B [1 - \gamma(1 - \chi\pi_A)]}{1 - \gamma(1 - \pi_A)}u_2 + \frac{\pi_C [1 - \gamma(1 - \chi\pi_A)]}{1 - \gamma(1 - \pi_A)}u_1 \\
\Leftrightarrow 0 &\leq (\pi_A [1 - \gamma\chi(1 - \pi_A)] + \pi_C [1 - \gamma(1 - \chi\pi_A)])u_2 - \pi_A [1 - \chi\gamma(1 - \pi_A)]u_3 \\
&\quad - \pi_C [1 - \gamma(1 - \chi\pi_A)]u_1 \\
\Leftrightarrow 0 &\leq \pi_A [1 - \chi\gamma(1 - \pi_A)](u_2 - u_3) - \pi_C [1 - \gamma(1 - \chi\pi_A)](u_1 - u_2) \\
\Leftrightarrow \chi\gamma(1 - \pi_A)\pi_A(u_2 - u_3) + \pi_C\gamma\chi\pi_A(u_1 - u_2) &\leq \pi_A(u_2 - u_3) - \pi_C[1 - \gamma](u_1 - u_2) \\
\Leftrightarrow \chi &\leq \frac{\pi_A(u_2 - u_3) - \pi_C[1 - \gamma](u_1 - u_2)}{\gamma\pi_A[(1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2)]}
\end{aligned}$$

In the limit as $\gamma \rightarrow 1$:

$$\chi \leq \frac{u_2 - u_3}{(1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2)}$$

Since the right-hand side is positive, this condition always holds for $\chi = 0$. Therefore, the near-revelation equilibrium always exists as a Bayes-Nash equilibrium in the limit as $\gamma \rightarrow 1$. \square

Lemma 2. Suppose that in equilibrium, only candidates who prefer C reveal their preferred policies. Then,

1. A Bayesian voter believes the following about a candidate who takes no

position:

$$\begin{aligned}\pi_{A|\emptyset} &= \frac{\pi_A}{1 - \gamma\pi_C} \\ \pi_{B|\emptyset} &= \frac{\pi_B}{1 - \gamma\pi_C} \\ \pi_{C|\emptyset} &= \frac{(1 - \gamma)\pi_C}{1 - \gamma\pi_C}\end{aligned}$$

In the limit as $\gamma \rightarrow 1$:

$$\begin{aligned}\pi_{A|\emptyset} &= \frac{\pi_A}{1 - \pi_C} \\ \pi_{B|\emptyset} &= \frac{\pi_B}{1 - \pi_C} \\ \pi_{C|\emptyset} &= 0\end{aligned}$$

2. A cursed voter believes the following about a candidate who takes no position:

$$\begin{aligned}\tilde{\pi}_{A|\emptyset} &= \frac{\pi_A [1 - \chi\gamma\pi_C]}{1 - \gamma\pi_C} \\ \tilde{\pi}_{B|\emptyset} &= \frac{\pi_B [1 - \chi\gamma\pi_C]}{1 - \gamma\pi_C} \\ \tilde{\pi}_{C|\emptyset} &= \frac{\pi_C [1 - \gamma + \chi\gamma(1 - \pi_C)]}{1 - \gamma\pi_C}\end{aligned}$$

In the limit as $\gamma \rightarrow 1$:

$$\begin{aligned}\tilde{\pi}_{A|\emptyset} &= \frac{\pi_A [1 - \chi\pi_C]}{1 - \pi_C} \\ \tilde{\pi}_{B|\emptyset} &= \frac{\pi_B [1 - \chi\pi_C]}{1 - \pi_C} \\ \tilde{\pi}_{C|\emptyset} &= \frac{\pi_C \chi (1 - \pi_C)}{1 - \pi_C}\end{aligned}$$

Proof. Given the equilibrium strategies chosen by candidates, Bayes' Rule im-

plies that

$$\begin{aligned}\pi_{A|\emptyset} &= \frac{\pi_A}{1 - \pi_C + (1 - \gamma)\pi_C} \\ \pi_{B|\emptyset} &= \frac{\pi_B}{1 - \pi_C + (1 - \gamma)\pi_C} \\ \pi_{C|\emptyset} &= \frac{(1 - \gamma)\pi_C}{1 - \pi_C + (1 - \gamma)\pi_C}\end{aligned}$$

From the definition of cursed equilibrium, the beliefs of a cursed voter are

$$\begin{aligned}\tilde{\pi}_{A|\emptyset} &= \chi\pi_A + \frac{(1 - \chi)\pi_A}{1 - \pi_C + (1 - \gamma)\pi_C} \\ \tilde{\pi}_{B|\emptyset} &= \chi\pi_B + \frac{(1 - \chi)\pi_B}{1 - \pi_C + (1 - \gamma)\pi_C} \\ \tilde{\pi}_{C|\emptyset} &= \chi\pi_C + \frac{(1 - \chi)(1 - \gamma)\pi_C}{1 - \pi_C + (1 - \gamma)\pi_C}\end{aligned}$$

Simplification of these equations yields those given in the statement of the Lemma. \square

Proposition 3. In the limit as $\gamma \rightarrow 1$, the ambiguity equilibrium does not exist as a Bayes-Nash equilibrium. **Proposition 4.** In the limit as $\gamma \rightarrow 1$, the ambiguity equilibrium exists as a cursed equilibrium if and only if

$$\chi \geq \chi_A \equiv \frac{\pi_A(u_2 - u_3)}{\pi_C[\pi_A(u_2 - u_3) + (1 - \pi_C)(u_1 - u_2)]} \quad (\text{A.2})$$

Proof. Suppose first that the median voter prefers a candidate who reveals B/D to a candidate who takes no position. Then, a candidate who prefers B/D would improve his probably of winning by deviating to revealing his preferred policy. Therefore, it must be the case that the median voter prefers a candidate who takes no position to one who reveals B/D. This is the case if and only if $u_2 \leq \tilde{\pi}_{A|\emptyset}u_3 + \tilde{\pi}_{B|\emptyset}u_2 + \tilde{\pi}_{C|\emptyset}u_1$.

Substituting the beliefs from Lemma 2 into the inequality above gives

$$\begin{aligned}
& u_2 \leq \frac{\pi_A (1 - \chi\gamma\pi_C)}{1 - \gamma\pi_C} u_3 + \frac{\pi_B (1 - \chi\gamma\pi_C)}{1 - \gamma\pi_C} u_2 + \frac{\pi_C (1 - \gamma + \chi\gamma(1 - \pi_C))}{1 - \gamma\pi_C} u_1 \\
\Leftrightarrow & 0 \leq \pi_A (1 - \chi\gamma\pi_C) u_3 + \pi_C (1 - \gamma + \chi\gamma(1 - \pi_C)) u_1 \\
& \quad - (\pi_A (1 - \chi\gamma\pi_C) + \pi_C (1 - \gamma + \chi\gamma(1 - \pi_C))) u_2 \\
\Leftrightarrow & 0 \leq \pi_C (1 - \gamma + \chi\gamma(1 - \pi_C)) (u_1 - u_2) - \pi_A (1 - \chi\gamma\pi_C) (u_2 - u_3) \\
\Leftrightarrow & 0 \leq \pi_C (1 - \gamma) (u_1 - u_2) - \pi_A (u_2 - u_3) \\
& \quad + \chi [\pi_C \gamma (1 - \pi_C) (u_1 - u_2) + \pi_A \gamma \pi_C (u_2 - u_3)] \\
\Leftrightarrow & \chi \geq \frac{\pi_A (u_2 - u_3) - \pi_C (1 - \gamma) (u_1 - u_2)}{\gamma \pi_C [(1 - \pi_C) (u_1 - u_2) + \pi_A (u_2 - u_3)]}
\end{aligned}$$

In the limit as $\gamma \rightarrow 1$:

$$\chi \geq \frac{\pi_A (u_2 - u_3)}{\pi_C [\pi_A (u_2 - u_3) + (1 - \pi_C) (u_1 - u_2)]}$$

Since the right-hand side is positive, the condition cannot hold for $\chi = 0$. Therefore, the ambiguity equilibrium does not exist as a Bayes-Nash equilibrium in the limit as $\gamma \rightarrow 1$. \square

Proposition 5. In the limit as $\gamma \rightarrow 1$:

1. If $\frac{\pi_A}{\pi_C} < \frac{u_1 - u_2}{u_2 - u_3}$, then:

(a) $0 < \chi_A < \chi_{NR} < 1$

(b) The near-revelation equilibrium is unique if and only if

$$\chi < \chi_A \equiv \frac{\pi_A [u_2 - u_3]}{\pi_C (\pi_A [u_2 - u_3] + (1 - \pi_C) [u_1 - u_2])} \quad (\text{A.3})$$

(c) The ambiguity equilibrium is unique if and only if

$$\chi > \chi_{NR} \equiv \frac{\pi_A (u_2 - u_3)}{\pi_A [(1 - \pi_A) (u_2 - u_3) + \pi_C (u_1 - u_2)]} \quad (\text{A.4})$$

- (d) The near-revelation and ambiguity equilibria both exist (and no other equilibria exist) if and only if $\chi_A \leq \chi \leq \chi_{NR}$
2. If $\frac{\pi_A}{\pi_C} = \frac{u_1 - u_2}{u_2 - u_3}$, then the near-revelation equilibrium is unique if $\chi < 1$, and both the near-revelation equilibrium and the ambiguity equilibrium exist if $\chi = 1$.
3. If $\frac{\pi_A}{\pi_C} > \frac{u_1 - u_2}{u_2 - u_3}$, then the near-revelation equilibrium is unique, for all values of χ .

Proof. The only possibility that has not been considered is an equilibrium in which only candidates who prefer B/D take no position. Suppose this equilibrium exists. Since a candidate who takes no position is a lottery that dominates A/E for certain, a candidate who prefers A/E could improve his winning probability by deviating to taking no position; therefore, this cannot be an equilibrium.

$\chi_{NR} = \frac{u_2 - u_3}{(1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2)}$ is clearly positive.

$$\begin{aligned}
 \chi_{NR} &\leq 1 \\
 &\Leftrightarrow u_2 - u_3 \leq (1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2) \\
 &\Leftrightarrow \pi_A(u_2 - u_3) \leq \pi_C(u_1 - u_2) \\
 &\Leftrightarrow \frac{\pi_A}{\pi_C} \leq \frac{u_1 - u_2}{u_2 - u_3}
 \end{aligned}$$

$\chi_A = \frac{\pi_A(u_2 - u_3)}{\pi_C[\pi_A(u_2 - u_3) + (1 - \pi_C)(u_1 - u_2)]}$ is also clearly positive.

$$\begin{aligned}
 \chi_A &\leq 1 \\
 &\Leftrightarrow \frac{\pi_A(u_2 - u_3)}{\pi_C[\pi_A(u_2 - u_3) + (1 - \pi_C)(u_1 - u_2)]} \leq 1 \\
 &\Leftrightarrow \pi_A(u_2 - u_3) \leq \pi_A\pi_C(u_2 - u_3) + \pi_C(1 - \pi_C)(u_1 - u_2) \\
 &\Leftrightarrow \pi_A(u_2 - u_3) \leq \pi_C(u_1 - u_2) \\
 &\Leftrightarrow \frac{\pi_A}{\pi_C} \leq \frac{u_1 - u_2}{u_2 - u_3}
 \end{aligned}$$

Next, $\chi_A \leq \chi_{NR}$ is equivalent to

$$\begin{aligned}
& \frac{\pi_A (u_2 - u_3)}{\pi_C [\pi_A (u_2 - u_3) + (1 - \pi_C) (u_1 - u_2)]} \leq \frac{u_2 - u_3}{(1 - \pi_A) (u_2 - u_3) + \pi_C (u_1 - u_2)} \\
& \Leftrightarrow \pi_A [(1 - \pi_A) (u_2 - u_3) + \pi_C (u_1 - u_2)] \leq \pi_C [\pi_A (u_2 - u_3) + (1 - \pi_C) (u_1 - u_2)] \\
& \Leftrightarrow \pi_A [1 - \pi_A - \pi_C] (u_2 - u_3) \leq \pi_C [1 - \pi_C - \pi_A] (u_1 - u_2) \\
& \Leftrightarrow \frac{\pi_A}{\pi_C} \leq \frac{u_1 - u_2}{u_2 - u_3}
\end{aligned}$$

To sum up, if $\frac{\pi_A}{\pi_C} < \frac{u_1 - u_2}{u_2 - u_3}$, then $0 < \chi_A < \chi_{NR} < 1$. If $\frac{\pi_A}{\pi_C} = \frac{u_1 - u_2}{u_2 - u_3}$, then $\chi_A = \chi_{NR} = 1$. Otherwise, both thresholds are above 1, implying that the Bayes-Nash equilibrium is unique. \square

Proposition 6. Suppose that π_A increases by ε , while π_B decreases by $\lambda\varepsilon$ and π_C decreases by $(1 - \lambda)\varepsilon$ for $\lambda \in [0, 1]$. Then, χ_{NR} and χ_A increase.

Proof. 1. χ_{NR} increases with this change if and only if

$$\frac{(\pi_A + \varepsilon)(u_2 - u_3) - (\pi_C - (1 - \lambda)\varepsilon)[1 - \gamma](u_1 - u_2)}{\gamma(\pi_A + \varepsilon)[(1 - (\pi_A + \varepsilon))(u_2 - u_3) + (\pi_C - (1 - \lambda)\varepsilon)(u_1 - u_2)]} > \frac{\pi_A(u_2 - u_3) - \pi_C[1 - \gamma](u_1 - u_2)}{\gamma\pi_A[(1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2)]}$$

Cross-multiplication gives

$$\begin{aligned}
& (\pi_A + \varepsilon)(u_2 - u_3)[\pi_A(1 - \pi_A)(u_2 - u_3)] \\
& (\pi_A + \varepsilon)(u_2 - u_3)[\pi_A\pi_C(u_1 - u_2)] \\
& - (\pi_C - (1 - \lambda)\varepsilon)[1 - \gamma](u_1 - u_2)[\pi_A\pi_C(u_1 - u_2)] \\
& - (\pi_C - (1 - \lambda)\varepsilon)[1 - \gamma](u_1 - u_2)[\pi_A(1 - \pi_A)(u_2 - u_3)] > \\
& \pi_A(u_2 - u_3)[(\pi_A + \varepsilon)(1 - (\pi_A + \varepsilon))(u_2 - u_3)] \\
& \pi_A(u_2 - u_3)[(\pi_A + \varepsilon)(\pi_C - (1 - \lambda)\varepsilon)(u_1 - u_2)] \\
& - \pi_C[1 - \gamma](u_1 - u_2)[(\pi_A + \varepsilon)(\pi_C - (1 - \lambda)\varepsilon)(u_1 - u_2)] \\
& - \pi_C[1 - \gamma](u_1 - u_2)[(\pi_A + \varepsilon)(1 - (\pi_A + \varepsilon))(u_2 - u_3)]
\end{aligned}$$

Distributing terms gives

$$\pi_A(1 - \pi_A)(\pi_A + \varepsilon)(u_2 - u_3)^2$$

$$\begin{aligned}
& +\pi_A\pi_C(\pi_A+\varepsilon)(u_2-u_3)(u_1-u_2) \\
& -(1-\gamma)\pi_A(1-\pi_A)(\pi_C-(1-\lambda)\varepsilon)(u_1-u_2)(u_2-u_3) \\
& -(1-\gamma)\pi_A\pi_C(\pi_C-(1-\lambda)\varepsilon)(u_1-u_2)^2 \\
& -\pi_A(\pi_A+\varepsilon)(1-(\pi_A+\varepsilon))(u_2-u_3)^2 \\
& -\pi_A(\pi_A+\varepsilon)(\pi_C-(1-\lambda)\varepsilon)(u_2-u_3)(u_1-u_2) \\
& +\pi_C[1-\gamma](\pi_A+\varepsilon)(1-(\pi_A+\varepsilon))(u_1-u_2)(u_2-u_3) \\
& +\pi_C[1-\gamma](\pi_A+\varepsilon)(\pi_C-(1-\lambda)\varepsilon)(u_1-u_2)^2 > 0
\end{aligned}$$

Suppose that $u_2 - u_3 > u_1 - u_2$. Then this condition holds if

$$\begin{aligned}
& \pi_A(1-\pi_A)(\pi_A+\varepsilon) + \pi_A\pi_C(\pi_A+\varepsilon) \\
& -(1-\gamma)\pi_A(1-\pi_A)(\pi_C-(1-\lambda)\varepsilon) - (1-\gamma)\pi_A\pi_C(\pi_C-(1-\lambda)\varepsilon) \\
& -\pi_A(\pi_A+\varepsilon)(1-(\pi_A+\varepsilon)) - \pi_A(\pi_A+\varepsilon)(\pi_C-(1-\lambda)\varepsilon) \\
& +\pi_C[1-\gamma](\pi_A+\varepsilon)(1-(\pi_A+\varepsilon)) + \pi_C[1-\gamma](\pi_A+\varepsilon)(\pi_C-(1-\lambda)\varepsilon) > 0
\end{aligned}$$

Note that the same condition would result if the opposite assumption had been made. This is equivalent to

$$(\pi_A + \varepsilon)(2 - \lambda)[\pi_A - \pi_C(1 - \gamma)] + (1 - \gamma)[\pi_C + \pi_A(1 - \lambda)][1 - \pi_A + \pi_C] > 0$$

Since only the first term in brackets could be negative, this must hold if $\pi_A \geq \pi_C$. The equation is also equivalent to

$$\begin{aligned}
& (1 - \gamma)\pi_C(\pi_C - \pi_A - \varepsilon(2 - \lambda)) \\
& + (\pi_A + \varepsilon)(2 - \lambda)\pi_A + (1 - \gamma)[\pi_C + \pi_A(1 - \lambda)](1 - \pi_A) > 0
\end{aligned}$$

This must hold if $\pi_C > \pi_A$, for sufficiently small ε . Therefore, it must hold for any initial values.

2. χ_A increases with this change if and only if

$$\frac{(\pi_A+\varepsilon)[u(x_2)-u(x_3)]-(\pi_C-\varepsilon(1-\lambda))(1-\gamma)[u(x_1)-u(x_2)]}{\gamma(\pi_C-\varepsilon(1-\lambda))(\pi_A+\varepsilon)[u(x_2)-u(x_3)]+(1-(\pi_C-\varepsilon(1-\lambda)))[u(x_1)-u(x_2)]} > \frac{\pi_A[u(x_2)-u(x_3)]-\pi_C(1-\gamma)[u(x_1)-u(x_2)]}{\gamma\pi_C(\pi_A[u(x_2)-u(x_3)]+(1-\pi_C)[u(x_1)-u(x_2)])}$$

Cross-multiplying gives

$$\begin{aligned}
& \gamma \pi_C \pi_A (\pi_A + \varepsilon) [u(x_2) - u(x_3)]^2 \\
& - \gamma \pi_C \pi_A (\pi_C - \varepsilon(1 - \lambda))(1 - \gamma) [u(x_1) - u(x_2)] [u(x_2) - u(x_3)] \\
& + (\pi_A + \varepsilon) \gamma \pi_C (1 - \pi_C) [u(x_1) - u(x_2)] [u(x_2) - u(x_3)] \\
& - (\pi_C - \varepsilon(1 - \lambda))(1 - \gamma) \gamma \pi_C (1 - \pi_C) [u(x_1) - u(x_2)]^2 \\
& - \pi_A \gamma (\pi_C - \varepsilon(1 - \lambda)) (\pi_A + \varepsilon) [u(x_2) - u(x_3)]^2 \\
& + \gamma (\pi_C - \varepsilon(1 - \lambda)) (\pi_A + \varepsilon) \pi_C (1 - \gamma) [u(x_1) - u(x_2)] [u(x_2) - u(x_3)] \\
& - \gamma \pi_A (\pi_C - \varepsilon(1 - \lambda))(1 - (\pi_C - \varepsilon(1 - \lambda))) [u(x_1) - u(x_2)] [u(x_2) - u(x_3)] \\
& + \gamma (\pi_C - \varepsilon(1 - \lambda))(1 - (\pi_C - \varepsilon(1 - \lambda))) \pi_C (1 - \gamma) [u(x_1) - u(x_2)]^2 > 0
\end{aligned}$$

Suppose that $u(x_2) - u(x_3) > u(x_1) - u(x_2)$. Then this condition holds if

$$\begin{aligned}
& \gamma \pi_C \pi_A (\pi_A + \varepsilon) - \gamma (1 - \gamma) \pi_C \pi_A (\pi_C - \varepsilon(1 - \lambda)) \\
& + (\pi_A + \varepsilon) \gamma \pi_C (1 - \pi_C) - (\pi_C - \varepsilon(1 - \lambda))(1 - \gamma) \gamma \pi_C (1 - \pi_C) \\
& - \pi_A \gamma (\pi_C - \varepsilon(1 - \lambda)) (\pi_A + \varepsilon) + \gamma (\pi_C - \varepsilon(1 - \lambda)) (\pi_A + \varepsilon) \pi_C (1 - \gamma) \\
& - \gamma \pi_A (\pi_C - \varepsilon(1 - \lambda))(1 - (\pi_C - \varepsilon(1 - \lambda))) \\
& + \gamma (\pi_C - \varepsilon(1 - \lambda))(1 - (\pi_C - \varepsilon(1 - \lambda))) \pi_C (1 - \gamma) > 0
\end{aligned}$$

Note that the same condition would result if the opposite assumption had been made. This is equivalent to

$$\begin{aligned}
& (\pi_A (1 - \lambda) + \pi_C) [1 - \gamma \pi_C] \\
& (1 - \lambda) [\pi_A - \pi_C (1 - \gamma)] (\pi_A - \pi_C + \varepsilon(2 - \lambda)) > 0
\end{aligned}$$

For sufficiently small ε , this must hold if $\pi_A > \pi_C$. This equation is also equivalent to

$$(1 - \lambda) \pi_A [1 + \pi_A - \pi_C + \varepsilon(2 - \lambda)] + \pi_C (1 - \gamma \pi_C - \gamma \pi_A (1 - \lambda))$$

$$+ (1 - \gamma) \pi_C (1 - \lambda) [\pi_C - \pi_A - \varepsilon (2 - \lambda)] > 0$$

It holds for sufficiently small ε if $\pi_C > \pi_A$. Therefore, it must hold for any initial values.

□

Proposition 7. Suppose that utility function u represents more risk-averse preferences than utility function v . Then χ_{NR} and χ_A are higher under u than under v .

Proof. Take two increasing functions, u and v , and consider preferences over three outcomes, z_1 , z_2 , and z_3 . $u(z_2) - u(z_3) = \phi(v(z_2) - v(z_3))$ for some positive constant ϕ ; since both differences are simply positive scalars, there must exist a positive constant that makes this equation hold. In addition, there exists φ such that $u(z_2) = \phi v(z_2) + \varphi$. Let $w(z) = \phi v(z) + \varphi$. Since Bernoulli utility functions are unique up to a linear transformation, $w(z)$ represents the same preferences as $v(z)$. $w(z_2) - w(z_3) = \phi v(z_2) + \varphi - \phi v(z_3) - \varphi = \phi(v(z_2) - v(z_3)) = u(z_2) - u(z_3)$: $u(z)$ and $w(z)$ have the same slope between z_2 and z_3 . Also, $w(z_2) = \phi v(z_2) + \varphi = u(z_2)$.

Let x be the certainty equivalent of Z under $u(\cdot)$: $u(x) = p_1 u(z_1) + p_2 u(z_2) + p_3 u(z_3)$. Rearranging, we have

$$\begin{aligned} & p_1 u(z_1) + p_2 u(z_2) + p_3 u(z_3) \\ &= p_1 u(z_1) + (1 - p_1 - p_3) u(z_2) + p_3 u(z_3) \\ &= p_1 (u(z_1) - u(z_2)) + u(z_2) + p_3 (u(z_3) - u(z_2)) \end{aligned}$$

Applying the same algebraic steps,

$$w(Z) = p_1 (w(z_1) - w(z_2)) + w(z_2) + p_3 (w(z_3) - w(z_2)).$$

From above, directly from the construction of $w(z)$, we have $w(z_2) = u(z_2)$ and

$w(z_2) - w(z_3) = u(z_2) - u(z_3)$. This implies that

$$w(Z) = p_1(w(z_1) - w(z_2)) + u(z_2) + p_3(u(z_3) - u(z_2)).$$

Add $p_1(u(z_1) - u(z_2))$ to both sides:

$$\begin{aligned} w(Z) + p_1(u(z_1) - u(z_2)) &= \\ p_1(w(z_1) - w(z_2)) + p_1(u(z_1) - u(z_2)) + p_3(u(z_3) - u(z_2)) \end{aligned}$$

Substitute in $u(Z)$ and rearrange:

$$w(Z) - u(Z) = p_1[(w(z_1) - w(z_2)) - (u(z_1) - u(z_2))]$$

$w(Z) > u(Z)$ if and only if $(w(z_1) - w(z_2)) > (u(z_1) - u(z_2))$. Under this condition, if x is indifferent to Z under $u(\cdot)$, then Z is strictly preferred to x (and therefore, there exists some $y > x$ such that $w(Z) = y$). Since w represents the same preferences as v , this is also true for v . Therefore, u has a lower certainty equivalent for lottery Z than v if and only if $w(z_1) - w(z_2) > u(z_1) - u(z_2)$.

The first part of this proof established that one can analyze the effects of differences in risk preferences by appropriately normalizing the utility functions (equivalently, redefining utility functions by taking affine transformations). Next, apply these transformations to the threshold conditions. Recall that

$$\chi_{NR} \equiv \frac{\pi_A(u_2 - u_3)}{\pi_A[(1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2)]}.$$

and

$$\chi_A \equiv \frac{\pi_A[u_2 - u_3]}{\pi_C(\pi_A[u_2 - u_3] + (1 - \pi_C)[u_1 - u_2])}.$$

Replacing $u(\cdot)$ with $w(\cdot)$ only increases the second term in the denominator of each equation. Therefore, χ_{NR} and χ_A are higher under $u(\cdot)$ (more risk-averse) than $v(\cdot)$. \square

Proposition 8. Suppose that the near-revelation equilibrium exists as a Bayes-Nash equilibrium and the ambiguity equilibrium exists as a cursed equilibrium. Then, as $\gamma \rightarrow 1$,

- The expected utility for players that prefer C and B/D is higher in the Bayes-Nash equilibrium than in the cursed equilibrium.
- The expected utility for players that prefer A/E is higher in the Bayes-Nash equilibrium than in the cursed equilibrium if and only if

$$u_2 + u_4 > u_1$$

Proof. • The expected utility of an agent that prefers C if the near-revelation equilibrium is played is

$$\begin{aligned} & \pi_A^2 u_3 + \pi_C^2 u_1 + 2\pi_A \pi_B \left[\gamma u_2 + (1 - \gamma) \left(\frac{1}{2} u_2 + \frac{1}{2} u_3 \right) \right] \\ & + 2\pi_A \pi_C \left[\gamma u_1 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right] + \pi_B^2 u_2 \\ & + 2\pi_B \pi_C \left[\gamma u_1 + \gamma (1 - \gamma) u_2 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_2 \right) \right] \end{aligned}$$

The expected utility of an agent that prefers C if the ambiguity equilibrium is played is

$$\begin{aligned} & \pi_A^2 u_3 + \pi_C^2 u_1 + 2\pi_A \pi_B \left[\frac{1}{2} u_2 + \frac{1}{2} u_3 \right] \\ & + 2\pi_A \pi_C \left[\gamma u_1 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right] + \pi_B^2 u_2 \\ & + 2\pi_B \pi_C \left[\gamma u_1 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_2 \right) \right] \end{aligned}$$

Her expected utility is higher in the near-revelation equilibrium than in the ambiguity equilibrium if and only if

$$\frac{\pi_A}{(1 - \gamma) \pi_C} \geq \frac{u_1 - u_2}{u_2 - u_3}$$

This is the same condition that must hold for the near-revelation equilibrium to exist as a Bayes-Nash equilibrium. Therefore, if the parameters are such that the Bayes-Nash equilibrium is the near-revelation equilibrium and the cursed equilibrium is the ambiguity equilibrium, then cursedness makes the median voter and candidates that prefer C worse off.

- The expected utility of an agent who prefers B/D if the near-revelation equilibrium is played is

$$\begin{aligned}
& \pi_A^2 \left[\frac{1}{2}u_2 + \frac{1}{2}u_4 \right] + \pi_A\pi_B \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_2 + \frac{1}{2}u_3 \right) \right] \\
& + \pi_B\pi_A \left[\gamma u_1 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\
& + \pi_A\pi_C u_2 + \pi_C\pi_A \left[\gamma u_2 + (1-\gamma) \left(\frac{1}{2}u_2 + \frac{1}{2}u_4 \right) \right] \\
& + \pi_B^2 \left[\frac{1}{2}u_1 + \frac{1}{2}u_3 \right] + \pi_C^2 u_2 \\
& + \pi_B\pi_C \left[\gamma^2 u_2 + \gamma(1-\gamma)u_1 + \gamma(1-\gamma)u_2 + (1-\gamma)^2 \left(\frac{1}{2}u_2 + \frac{1}{2}u_1 \right) \right] \\
& + \pi_C\pi_B \left[\gamma^2 u_2 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_2 + \frac{1}{2}u_3 \right) \right]
\end{aligned}$$

The expected utility of an agent who prefers B/D if the ambiguity equilibrium is played is

$$\begin{aligned}
& \pi_A^2 \left[\frac{1}{2}u_2 + \frac{1}{2}u_4 \right] + \pi_A\pi_B \left[\frac{1}{2}u_2 + \frac{1}{2}u_3 \right] + \pi_B\pi_A \left[\frac{1}{2}u_1 + \frac{1}{2}u_4 \right] \\
& + \pi_A\pi_C u_2 + \pi_C\pi_A \left[\gamma u_2 + (1-\gamma) \left(\frac{1}{2}u_2 + \frac{1}{2}u_4 \right) \right] \\
& + \pi_B^2 \left[\frac{1}{2}u_1 + \frac{1}{2}u_3 \right] + \pi_C^2 u_2 \\
& + \pi_B\pi_C \left[\gamma u_2 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right] + \pi_C\pi_B \left[\gamma u_2 + (1-\gamma) \left(\frac{1}{2}u_2 + \frac{1}{2}u_3 \right) \right]
\end{aligned}$$

His expected utility is higher in the near-revelation equilibrium than in the

ambiguity equilibrium if and only if

$$\frac{\pi_A}{\pi_C(1-\gamma)} > \frac{2u_2 - u_1 - u_3}{u_1 - u_2 + u_3 - u_4}$$

As $\gamma \rightarrow 1$, the left-hand side approaches infinity; therefore, this condition must hold.

- The expected utility of an agent that prefers A/E if the near-revelation equilibrium is played is

$$\begin{aligned} & \pi_A^2 \left[\frac{1}{2}u_1 + \frac{1}{2}u_5 \right] + \pi_A\pi_B \left[\gamma u_4 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_B\pi_A \left[\gamma u_2 + (1-\gamma) \left(\frac{1}{2}u_2 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_A\pi_C \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \\ & + \pi_C\pi_A \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_3 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_B^2 \left[\frac{1}{2}u_2 + \frac{1}{2}u_4 \right] + \pi_C^2 u_3 \\ & + \pi_B\pi_C \left[\gamma^2 u_3 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_3 + \frac{1}{2}u_2 \right) \right] \\ & + \pi_C\pi_B \left[\gamma^2 u_3 + \gamma(1-\gamma)u_4 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_3 + \frac{1}{2}u_4 \right) \right] \end{aligned}$$

The expected utility of an agent that prefers A/E if the ambiguity equilibrium is played is

$$\begin{aligned} & \pi_A^2 \left[\frac{1}{2}u_1 + \frac{1}{2}u_5 \right] + \pi_A\pi_B \left[\frac{1}{2}u_1 + \frac{1}{2}u_4 \right] + \pi_B\pi_A \left[\frac{1}{2}u_2 + \frac{1}{2}u_5 \right] \\ & + \pi_A\pi_C \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] + \pi_C\pi_A \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_3 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_B^2 \left[\frac{1}{2}u_2 + \frac{1}{2}u_4 \right] + \pi_C^2 u_3 \\ & + \pi_B\pi_C \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_2 + \frac{1}{2}u_3 \right) \right] + \pi_C\pi_B \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_3 + \frac{1}{2}u_4 \right) \right] \end{aligned}$$

His expected utility is higher in the near-revelation equilibrium than in the ambiguity equilibrium if and only if

$$\frac{\pi_A}{\pi_C(1-\gamma)}[u_2 + u_4 - u_1] > 2u_3 - u_2 - u_4$$

As $\gamma \rightarrow 1$, the left-hand side goes to infinity if $u_2 + u_4 > u_1$ and goes to negative infinity otherwise. Thus, the condition holds if and only if $u_2 + u_4 > u_1$.

□

A.1.2 Commitment Game

Proposition 9. In the limit as $\gamma \rightarrow 1$, the near-revelation equilibrium exists if and only if the following conditions hold:

$$\chi \leq \chi_{NR} \equiv \frac{u_2 - u_3}{(1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2)} \quad (\text{A.5})$$

$$\frac{2u_2 - u_1 - u_3}{u_1 - u_3} \leq \frac{\pi_A}{\pi_A + \pi_B} \quad (\text{A.6})$$

$$\frac{\frac{1}{2}u_1 - u_4}{u_3 - u_4} \geq \frac{\pi_A + \pi_B}{\pi_A} \quad (\text{A.7})$$

$$\frac{u_1 - u_2 - u_4}{u_2 - u_4} \geq \frac{\pi_A + \pi_B}{\pi_A} \quad (\text{A.8})$$

Proof. Suppose to the contrary that this equilibrium does not exist. Then, a candidate who prefers B/D could profitably deviate by committing to C, a candidate who prefers B/D could profitably deviate by taking no position, a candidate who prefers A/E could profitably deviate by committing to B/D, and/or a candidate who prefers A/E could profitably deviate by committing to C. Consider each case in turn.

The median voter prefers a candidate commits to B/D to a candidate who

takes no position; this is true if and only if equation A.5 (derived in the proof of Proposition 2) holds. Given this, a candidate who prefers B/D has an equilibrium payoff of

$$\begin{aligned} & \pi_A \left(\gamma u_1 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right) \\ & + \pi_B \left[\left(\gamma^2 + (1 - \gamma)^2 \right) \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) + \gamma (1 - \gamma) u_1 + \gamma (1 - \gamma) u_3 \right] \\ & + \pi_C \left[\gamma^2 u_2 + \gamma (1 - \gamma) u_1 + \gamma (1 - \gamma) u_2 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_2 \right) \right] \end{aligned}$$

If he deviated by committing to C, his payoff would be:

$$\begin{aligned} & \pi_A \left(\gamma u_2 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right) \\ & + \pi_B \left[\gamma^2 u_2 + \gamma (1 - \gamma) u_2 + \gamma (1 - \gamma) u_3 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right] \\ & + \pi_C \left[\gamma^2 u_2 + \gamma (1 - \gamma) u_2 + \gamma (1 - \gamma) u_2 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_2 \right) \right] \end{aligned}$$

He would choose *not* to make this deviation if and only if

$$\begin{aligned} \pi_A (u_1 - u_2) + \pi_B \left[\left(1 - \frac{1}{2} \gamma \right) u_1 + \frac{1}{2} \gamma u_3 - u_2 \right] \\ + \pi_C (1 - \gamma) [u_1 - u_2] \geq 0 \end{aligned}$$

As $\gamma \rightarrow 1$:

$$\begin{aligned} & \pi_A (u_1 - u_2) + \pi_B \left[\frac{1}{2} u_1 + \frac{1}{2} u_3 - u_2 \right] \geq 0 \\ \Leftrightarrow & \frac{1}{2} \pi_A (u_1 - u_3) + (1 - \pi_C) \left[\frac{1}{2} u_1 + \frac{1}{2} u_3 - u_2 \right] \geq 0 \end{aligned}$$

$$\Leftrightarrow \frac{\pi_A}{\pi_A + \pi_B} > \frac{2u_2 - u_1 - u_3}{u_1 - u_3}$$

Next, consider the possibility that this candidate instead deviates to taking no position. Since we have assumed that voters prefer a candidate who commits to

B/D, by deviating, he would reduce his probability of winning without changing his payoff conditional on winning. Thus, he would not make this deviation. The equilibrium payoff of a candidate who prefers A/E is:

$$\pi_A \left[\frac{1}{2}u_1 + \frac{1}{2}u_5 \right] + \pi_B \left[\gamma u_4 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ + \pi_C \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right]$$

If he deviates by committing to C, his payoff would be:

$$\pi_A \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right] \\ + \pi_B \left[\gamma^2 u_3 + \gamma(1 - \gamma)u_3 + \gamma(1 - \gamma)u_4 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ + \pi_C \left[\gamma^2 u_3 + \gamma(1 - \gamma)u_3 + \gamma(1 - \gamma)u_3 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right]$$

He would choose *not* to make this deviation if and only if

$$\pi_A [u_1 - 2u_3] + \pi_B [(1 - \gamma)u_1 + (1 + \gamma)u_4 - 2u_3] \\ + \pi_C (1 - \gamma)[u_1 - u_3] \geq 0$$

As $\gamma \rightarrow 1$:

$$\pi_A [u_1 - 2u_2] + \pi_B [u_4 - u_2] \geq 0 \\ \Leftrightarrow \pi_A [u_1 - u_2 - u_4] - (1 - \pi_C)[u_2 - u_4] \geq 0 \\ \Leftrightarrow \frac{u_1 - u_2 - u_4}{u_2 - u_4} \geq \frac{\pi_A + \pi_B}{\pi_A}$$

If instead he deviates by committing to B/D, his payoff would be:

$$\pi_A \left[\gamma u_2 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right]$$

$$\begin{aligned}
& + \pi_B \left[\left(\frac{1}{2} \gamma^2 + \gamma(1-\gamma) \right) (u_2 + u_4) + (1-\gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right] \\
& + \pi_C \left[\gamma^2 u_3 + \gamma(1-\gamma) u_2 + \gamma(1-\gamma) u_3 + (1-\gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right]
\end{aligned}$$

He would choose *not* to make this deviation if and only if

$$\begin{aligned}
& \pi_A [u_1 - 2u_2] + \pi_B [u_4 + (1-\gamma) u_1 - (2-\gamma) u_2] \\
& + (1-\gamma) \pi_C [u_1 + u_3 - 2u_2] \geq 0
\end{aligned}$$

As $\gamma \rightarrow 1$:

$$\begin{aligned}
& \pi_A [u_1 - 2u_2] + \pi_B [u_4 - u_2] \geq 0 \\
& \Leftrightarrow \pi_A [u_1 - u_2 - u_4] - (1 - \pi_C) [u_2 - u_4] \geq 0 \\
& \Leftrightarrow \frac{u_1 - u_2 - u_4}{u_2 - u_4} \geq \frac{\pi_A + \pi_B}{\pi_A}
\end{aligned}$$

□

Proposition 10. In the limit as $\gamma \rightarrow 1$, the ambiguity equilibrium exists if and only if the following conditions hold:

$$\chi \geq \chi_A \equiv \frac{\pi_A (u_2 - u_3)}{\pi_C [\pi_A (u_2 - u_3) + (1 - \pi_C) (u_1 - u_2)]} \quad (\text{A.9})$$

$$\frac{u_1 + u_3 - 2u_2}{u_3 - u_4} \geq \frac{\pi_A}{\pi_A + \pi_B} \quad (\text{A.10})$$

$$\frac{u_1 + u_4 - 2u_3}{u_4} \geq \frac{\pi_A}{\pi_A + \pi_B} \quad (\text{A.11})$$

Proof. To establish this, we must consider the following possible deviations: a candidate who prefers B/D deviates to B/D, a candidate who prefers B/D deviates to C, a candidate who prefers A/E deviates to B/D, and a candidate who prefers A/E deviates to C. The median voter prefers a candidate who takes no position to a candidate who commits to B/D; this is true if and only if equation

A.9 (derived in the proof of Proposition 4) holds. Given this, no candidate could profitably deviate by committing to B/D, since a candidate who did this could only win the election by being randomly prevented from making this commitment.

The equilibrium payoff of a candidate who prefers B/D is

$$\begin{aligned} & \pi_A \left[\frac{1}{2}u_1 + \frac{1}{2}u_4 \right] + \pi_B \left[\frac{1}{2}u_1 + \frac{1}{2}u_3 \right] \\ & + \pi_C \left[\gamma u_2 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right] \end{aligned}$$

If he deviates and commits to C, his payoff would be

$$\begin{aligned} & \pi_A \left[\gamma u_2 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_B \left[\gamma u_2 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \\ & + \pi_C \left[\gamma^2 u_2 + 2\gamma(1 - \gamma)u_2 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right] \end{aligned}$$

He would *not* choose to deviate if and only if

$$\begin{aligned} & \pi_A [u_1 + u_4 - 2u_2] + \pi_B [u_1 + u_3 - 2u_2] \\ & + \pi_C (1 - \gamma) [u_1 - u_2] \geq 0 \end{aligned}$$

As $\gamma \rightarrow 1$:

$$\begin{aligned} & \pi_A [u_1 + u_4 - 2u_2] + \pi_B [u_1 + u_3 - 2u_2] \geq 0 \\ \Leftrightarrow & (1 - \pi_C) [u_1 + u_3 - 2u_2] - \pi_A [u_3 - u_4] \geq 0 \\ \Leftrightarrow & \frac{u_1 + u_3 - 2u_2}{u_3 - u_4} \geq \frac{\pi_A}{\pi_A + \pi_B} \end{aligned}$$

The equilibrium payoff of a candidate who prefers A/E is

$$\begin{aligned} & \pi_A \left[\frac{1}{2}u_1 + \frac{1}{2}u_5 \right] + \pi_B \left[\frac{1}{2}u_1 + \frac{1}{2}u_4 \right] \\ & + \pi_C \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \end{aligned}$$

If he deviates and commits to C, his payoff would be

$$\begin{aligned} & \pi_A \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_B \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_C \left[\gamma^2 u_3 + 2\gamma(1 - \gamma)u_3 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \end{aligned}$$

He would *not* choose to deviate if and only if

$$\pi_A [u_1 - 2u_3] + \pi_B [u_1 + u_4 - 2u_3] + \pi_C (1 - \gamma) [u_1 - u_3] \geq 0$$

As $\gamma \rightarrow 1$:

$$\pi_A [u_1 - 2u_3] + \pi_B [u_1 + u_4 - 2u_3] \geq 0$$

$$\Leftrightarrow (1 - \pi_C) [u_1 + u_4 - 2u_3] - \pi_A u_4 \geq 0$$

$$\Leftrightarrow \frac{u_1 + u_4 - 2u_3}{u_4} \geq \frac{\pi_A}{\pi_A + \pi_B}$$

□

Proposition 11. In the limit as $\gamma \rightarrow 1$:

1. The near-centrist equilibrium exists if and only if the following conditions hold:

$$2u_2 - u_1 - u_4 \geq 0 \tag{A.12}$$

$$u_1 - 2u_3 \geq 0 \tag{A.13}$$

$$\chi \geq \chi_{NR} \equiv \frac{u_2 - u_3}{(1 - \pi_A)(u_2 - u_3) + \pi_C(u_1 - u_2)} \quad (\text{A.14})$$

2. The centrist equilibrium exists if and only if

$$u_2 \leq \pi_A u_3 + \pi_B u_2 + \pi_C u_1 \quad (\text{A.15})$$

3. The centrist-B equilibrium exists if and only if

$$u_2 \geq \pi_A u_3 + \pi_B u_2 + \pi_C u_1 \quad (\text{A.16})$$

4. The commitment I equilibrium exists if and only if the following conditions hold:

$$\frac{2u_2 - u_1 - u_3}{u_1 - u_3} \leq \frac{\pi_A}{\pi_A + \pi_B} \quad (\text{A.17})$$

$$\frac{1}{2}u_2 + \frac{1}{2}u_4 - u_3 \geq 0 \quad (\text{A.18})$$

$$u_2 \geq \pi_A u_3 + \pi_B u_2 + \pi_C u_1 \quad (\text{A.19})$$

Proof. 1. **Near-centrist equilibrium:** The median voter prefers a candidate who takes no position to one who commits to B/D. This implies that we need not consider deviations to B/D, since the expected payoff from taking no position is higher. The equilibrium payoff for a candidate who prefers B/D is

$$\begin{aligned} & \pi_A \left[\gamma u_2 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_B \left[\gamma^2 u_2 + 2\gamma(1 - \gamma)u_2 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \\ & + \pi_C \left[\gamma^2 u_2 + 2\gamma(1 - \gamma)u_2 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right] \end{aligned}$$

If he deviated to taking no position, his payoff would be

$$\pi_A \left[\frac{1}{2}u_1 + \frac{1}{2}u_4 \right] + \pi_B \left[\gamma u_2 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \\ + \pi_C \left[\gamma u_2 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right]$$

He would *not* choose to deviate if and only if

$$\pi_A [2u_2 - u_1 - u_4] + \pi_B (1 - \gamma) [2u_2 - u_1 - u_3] \\ + \pi_C (1 - \gamma) [u_2 - u_1] \geq 0$$

As $\gamma \rightarrow 1$:

$$2u_2 - u_1 - u_4 \geq 0$$

The equilibrium payoff for a candidate who prefers A/E is

$$\pi_A \left[\frac{1}{2}u_1 + \frac{1}{2}u_5 \right] + \pi_B \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ + \pi_C \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right]$$

If he deviated to committing to C, his payoff would be

$$\pi_A \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right] \\ + \pi_B \left[\gamma^2 u_3 + 2\gamma(1 - \gamma)u_3 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ + \pi_C \left[\gamma^2 u_3 + 2\gamma(1 - \gamma)u_3 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right]$$

He would *not* choose to deviate if and only if

$$\pi_A [u_1 - 2u_3] + \pi_B (1 - \gamma) [u_1 + u_4 - 2u_3] \\ + \pi_C (1 - \gamma) [u_1 - u_3] \geq 0$$

As $\gamma \rightarrow 1$:

$$u_1 - 2u_3 \geq 0$$

We also require that the median voter prefers a candidate who takes no position to one who commits to B/D, which holds if and only if $\tilde{\pi}_{A|n}u_3 + \tilde{\pi}_{B|n}u_2 + \tilde{\pi}_{C|n}u_1 > u_2$, where

$$\begin{aligned}\tilde{\pi}_{A|n} &= \frac{\pi_A (\chi (\pi_C (1 - \gamma) + \pi_B (1 - \gamma) + \pi_A) + (1 - \chi))}{\pi_C (1 - \gamma) + \pi_B (1 - \gamma) + \pi_A} \\ \tilde{\pi}_{B|n} &= \frac{\pi_B (\chi (\pi_C (1 - \gamma) + \pi_B (1 - \gamma) + \pi_A) + (1 - \chi) (1 - \gamma))}{\pi_C (1 - \gamma) + \pi_B (1 - \gamma) + \pi_A} \\ \tilde{\pi}_{C|n} &= \frac{\pi_C (\chi (\pi_C (1 - \gamma) + \pi_B (1 - \gamma) + \pi_A) + (1 - \chi) (1 - \gamma))}{\pi_C (1 - \gamma) + \pi_B (1 - \gamma) + \pi_A}\end{aligned}$$

This is true if and only if equation A.14 holds.

2. **Centrist equilibrium:** To show that this equilibrium exists, we must show that candidates would not make the following deviations: a candidate who prefers B/D would not deviate to committing to B/D or taking no position, and a candidate who prefers A/E would not deviate to committing to B/D or taking no position. The median voter prefers a candidate who takes no position to one that commits to B/D. Since candidates only take no position if they are prevented from committing, beliefs about a candidate who take no position are simply the prior beliefs and do not depend on χ . This holds if

$$u_2 \leq \pi_A u_3 + \pi_B u_2 + \pi_C u_1$$

The equilibrium payoff of a candidate that prefers B/D is

$$\begin{aligned}& \pi_A \left[\gamma^2 u_2 + \gamma (1 - \gamma) u_2 + \gamma (1 - \gamma) u_2 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right] \\ & + \pi_B \left[\gamma^2 u_2 + \gamma (1 - \gamma) u_2 + \gamma (1 - \gamma) u_2 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right]\end{aligned}$$

$$+\pi_C \left[\gamma^2 u_2 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_2 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right]$$

If he deviates to taking no position, his payoff is

$$\begin{aligned} & \pi_A \left[\gamma u_2 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_B \left[\gamma u_2 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \\ & + \pi_C \left[\gamma u_2 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right] \end{aligned}$$

He would not choose to deviate if and only if

$$\begin{aligned} (1-\gamma) \left[u_2 - \frac{1}{2}u_1 - \frac{1}{2}\pi_A u_4 - \frac{1}{2}\pi_B u_3 - \frac{1}{2}\pi_C u_2 \right] & \geq 0 \\ \Leftrightarrow (1-\gamma) [2u_2 - u_1 - u_3 + \pi_A (u_3 - u_4) - \pi_C (u_2 - u_3)] & \geq 0 \end{aligned}$$

In the limit as $\gamma \rightarrow 1$, his incentive to deviate disappears. The equilibrium payoff of a candidate that prefers A/E is

$$\begin{aligned} & \pi_A \left[\gamma^2 u_3 + \gamma(1-\gamma)u_3 + (1-\gamma)\gamma u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_B \left[\gamma^2 u_3 + \gamma(1-\gamma)u_3 + (1-\gamma)\gamma u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_C \left[\gamma^2 u_3 + \gamma(1-\gamma)u_3 + (1-\gamma)\gamma u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \end{aligned}$$

If he deviated to taking no position, his payoff would be

$$\begin{aligned} & \pi_A \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_B \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_C \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \end{aligned}$$

He would not choose to deviate if and only if

$$(1 - \gamma) \left[u_3 - \frac{1}{2}u_1 - \frac{1}{2}\pi_B u_4 - \frac{1}{2}\pi_C u_3 \right] \geq 0$$

$$\Leftrightarrow (1 - \gamma) [2u_3 - u_1 - u_4 + \pi_A u_4 - \pi_C (u_3 - u_4)] \geq 0$$

In the limit as $\gamma \rightarrow 1$, his incentive to deviate disappears. No candidate would deviate to committing to B/D, because the payoff from doing so would be less than that from deviating to taking no position.

3. **Centrist-B equilibrium:** The median voter prefers a candidate that commits to B/D to a candidate that takes no position. Since no candidate commits to B/D in equilibrium, this alternative assumption does not affect equilibrium payoffs, compared to those in the centrist equilibrium.

If a candidate who prefers B/D deviated to committing to B/D, his expected payoff would be

$$\pi_A \left[\gamma^2 u_2 + \gamma(1 - \gamma)u_1 + (1 - \gamma)\gamma u_2 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right]$$

$$+ \pi_B \left[\gamma^2 u_2 + \gamma(1 - \gamma)u_1 + (1 - \gamma)\gamma u_2 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right]$$

$$+ \pi_C \left[\gamma^2 u_2 + \gamma(1 - \gamma)u_1 + (1 - \gamma)\gamma u_2 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right]$$

He would not choose to deviate if and only if

$$\gamma(1 - \gamma) [u_2 - u_1] \geq 0$$

This will be violated if $\gamma < 1$. However, in the limit as $\gamma \rightarrow 1$, the incentive to deviate still disappears. If a candidate that prefers A/E deviated to committing to B/D, his expected payoff would be

$$\pi_A \left[\gamma^2 u_3 + \gamma(1 - \gamma)u_2 + \gamma(1 - \gamma)u_3 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right]$$

$$+ \pi_B \left[\gamma^2 u_3 + \gamma(1 - \gamma)u_2 + \gamma(1 - \gamma)u_3 + (1 - \gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right]$$

$$+\pi_C \left[\gamma^2 u_3 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right]$$

He would not deviate if and only if

$$(1-\gamma)[u_3 - u_2] \geq 0$$

This will also be violated if $\gamma < 1$. However, in the limit as $\gamma \rightarrow 1$, the incentive to deviate still disappears. If instead a candidate that prefers A/E deviates to taking no position, his expected payoff would be

$$\begin{aligned} & \pi_A \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_B \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_C \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \end{aligned}$$

He would not deviate if and only if

$$(1-\gamma) \left[u_3 - \frac{1}{2}u_1 - \frac{1}{2}u_4 + \frac{1}{2}u_4\pi_A - \frac{1}{2}\pi_C(u_3 - u_4) \right] \geq 0$$

In the limit as $\gamma \rightarrow 1$, the incentive to deviate disappears.

Therefore, in the limit as $\gamma \rightarrow 1$, there exists an equilibrium in which all candidates commit to C, regardless of the median voter's risk preferences (either the centrist or centrist-B equilibrium). However, if $\gamma < 1$, the median voter must prefer a random draw to a candidate that commits to B/D (centrist equilibrium).

4. **Commitment I equilibrium:** Now, suppose that voters prefer a candidate who commits to B/D to one who takes no position. In this case, a candidate who prefers B/D would not deviate to taking no position, since this would only lose him votes. The equilibrium payoff for a candidate who

prefers B/D is

$$\begin{aligned} & \pi_A \left[\gamma^2 u_1 + \gamma(1-\gamma)u_1 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_B \left[\left(\frac{1}{2}\gamma^2 + \gamma(1-\gamma) \right) (u_1 + u_3) + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \\ & + \pi_C \left[\left(\gamma^2 + \gamma(1-\gamma) \right) u_2 + \gamma(1-\gamma)u_1 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right] \end{aligned}$$

If he deviated and committed to C, his payoff would be

$$\begin{aligned} & \pi_A \left[\gamma^2 u_2 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_2 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_B \left[\gamma^2 u_2 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \\ & + \pi_C \left[\gamma^2 u_2 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_2 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right] \end{aligned}$$

He would *not* deviate if and only if

$$\begin{aligned} \pi_A [u_1 - u_2] + \pi_B \left[\left(1 - \frac{1}{2}\gamma \right) u_1 + \frac{1}{2}\gamma u_3 - u_2 \right] \\ + \pi_C (1-\gamma)(u_1 - u_2) \geq 0 \end{aligned}$$

As $\gamma \rightarrow 1$:

$$\begin{aligned} & \pi_A [u_1 - u_2] + \pi_B \left[\frac{1}{2}u_1 + \frac{1}{2}u_3 - u_2 \right] \geq 0 \\ \Leftrightarrow & \frac{1}{2}\pi_A [u_1 - u_3] + (1-\pi_C) \left[\frac{1}{2}u_1 + \frac{1}{2}u_3 - u_2 \right] \geq 0 \end{aligned}$$

$$\Leftrightarrow \frac{2u_2 - u_1 - u_3}{u_1 - u_3} \leq \frac{\pi_A}{\pi_A + \pi_B}$$

The equilibrium payoff for a candidate who prefers A/E is

$$\pi_A \left[\left(\frac{1}{2}\gamma^2 + \gamma(1-\gamma) \right) (u_2 + u_4) + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right]$$

$$\begin{aligned}
& +\pi_B \left[\left(\frac{1}{2} \gamma^2 + \gamma (1 - \gamma) \right) (u_2 + u_4) + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right] \\
& +\pi_C \left[\gamma u_3 + \gamma (1 - \gamma) u_2 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right]
\end{aligned}$$

If he deviated to committing to C, his payoff would be

$$\begin{aligned}
& \pi_A \left[\gamma^2 u_3 + \gamma (1 - \gamma) u_3 + \gamma (1 - \gamma) u_4 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_5 \right) \right] \\
& +\pi_B \left[\gamma^2 u_3 + \gamma (1 - \gamma) u_3 + \gamma (1 - \gamma) u_4 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right] \\
& +\pi_C \left[\gamma^2 u_3 + \gamma (1 - \gamma) u_3 + \gamma (1 - \gamma) u_3 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right]
\end{aligned}$$

He would *not* deviate if and only if

$$(\pi_A + \pi_B) \left[\left(1 - \frac{1}{2} \gamma \right) u_2 + \frac{1}{2} \gamma u_4 - u_3 \right] + \pi_C [(1 - \gamma) (u_2 - u_3)] \geq 0$$

As $\gamma \rightarrow 1$:

$$\frac{1}{2} u_2 + \frac{1}{2} u_4 - u_3 \geq 0$$

If he deviated to taking no position, his payoff would be

$$\begin{aligned}
& \pi_A \left[\gamma u_4 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_5 \right) \right] \\
& +\pi_B \left[\gamma u_4 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right] \\
& +\pi_C \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right]
\end{aligned}$$

He would *not* deviate if and only if

$$\begin{aligned}
& \pi_A \left[\left(1 - \frac{1}{2} \gamma \right) u_2 - \frac{1}{2} \gamma u_4 - \frac{1}{2} (1 - \gamma) u_1 \right] \\
& +\pi_B \left[\left(1 - \frac{1}{2} \gamma \right) u_2 - \frac{1}{2} (1 - \gamma) u_1 - \frac{1}{2} u_4 \right] \\
& +\pi_C (1 - \gamma) \left[u_2 - \frac{1}{2} u_1 - \frac{1}{2} u_3 \right] \geq 0
\end{aligned}$$

As $\gamma \rightarrow 1$:

$$u_2 \geq u_4$$

This holds by definition of the utility function.

□

Definition 6. *Commitment II equilibrium: Candidates who prefer B/D or C commit to C and candidates who prefer A/E commit to B/D. The median voter votes for a candidate who commits to B/D over a candidate who takes no position.*

Proposition 13. *In the limit as $\gamma \rightarrow 1$, the commitment II equilibrium exists if and only if the following conditions hold:*

$$u_2 - \frac{1}{2}u_1 - \frac{1}{2}u_3 \geq 0 \quad (\text{A.20})$$

$$\frac{1}{2}u_2 + \frac{1}{2}u_4 - u_3 \geq 0 \quad (\text{A.21})$$

$$u_2 > \pi_A u_3 + \pi_B u_2 + \pi_C u_1 \quad (\text{A.22})$$

Proof. The median voter prefers a candidate who commits to B/D to one who takes no position; this is true if and only if equation A.22 holds. The equilibrium payoff for a candidate who prefers B/D is

$$\begin{aligned} & \pi_A \left[\gamma^2 u_2 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_B \left[\gamma^2 u_2 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_2 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \\ & + \pi_C \left[\gamma^2 u_2 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_2 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right] \end{aligned}$$

If he deviated and committed to B/D, his payoff would be

$$\begin{aligned} & \pi_A \left[\left(\frac{1}{2}\gamma^2 + \gamma(1-\gamma) \right) (u_1 + u_3) + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_B \left[\gamma^2 u_2 + \gamma(1-\gamma)u_1 + \gamma(1-\gamma)u_2 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \end{aligned}$$

$$+\pi_C \left[\gamma^2 u_2 + \gamma(1-\gamma)u_1 + \gamma(1-\gamma)u_2 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_2 \right) \right]$$

He would *not* choose to deviate if and only if

$$\pi_A \left[u_2 - \left(1 - \frac{1}{2}\gamma \right) u_1 - \frac{1}{2}\gamma u_3 \right] + (\pi_B + \pi_C)(1-\gamma)[u_2 - u_1] \geq 0$$

As $\gamma \rightarrow 1$:

$$u_2 - \frac{1}{2}u_1 - \frac{1}{2}u_3 \geq 0$$

By definition, this implies that candidates are risk-loving between distances 0 and 2. The equilibrium payoff for a candidate who prefers A/E is

$$\begin{aligned} & \pi_A \left[\left(\frac{1}{2}\gamma^2 + \gamma(1-\gamma) \right) (u_2 + u_4) + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_B \left[\gamma^2 u_3 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_C \left[\gamma^2 u_3 + \gamma(1-\gamma)u_2 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \end{aligned}$$

If he deviated and committed to C, his payoff would be

$$\begin{aligned} & \pi_A \left[\gamma^2 u_3 + \gamma(1-\gamma)u_3 + \gamma(1-\gamma)u_4 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_B \left[\gamma^2 u_3 + \gamma(1-\gamma)u_3 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_C \left[\gamma^2 u_3 + \gamma(1-\gamma)u_3 + \gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \end{aligned}$$

He would *not* deviate if and only if

$$\pi_A \left[\left(1 - \frac{1}{2}\gamma \right) u_2 + \frac{1}{2}\gamma u_4 - u_3 \right] + (\pi_B + \pi_C)(1-\gamma)[u_2 - u_3] \geq 0$$

As $\gamma \rightarrow 1$:

$$\frac{1}{2}u_2 + \frac{1}{2}u_4 - u_3 \geq 0$$

This implies that he must be risk-averse between distances of 1 and 3. Therefore, if one assumes that the candidates must have consistent risk preferences over policies across the entire policy space, then this equilibrium does not exist. If he deviated and took no position, his payoff would be

$$\begin{aligned} & \pi_A \left[\gamma u_4 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_5 \right) \right] \\ & + \pi_B \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right] \\ & + \pi_C \left[\gamma u_3 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right] \end{aligned}$$

He would *not* deviate if and only if

$$\begin{aligned} & \pi_A \left[\left(1 - \frac{1}{2} \gamma \right) u_2 - \frac{1}{2} \gamma u_4 - \frac{1}{2} (1 - \gamma) u_1 \right] \\ & + \pi_B (1 - \gamma) \left[u_2 - \frac{1}{2} u_1 - \frac{1}{2} u_4 \right] \\ & + \pi_C (1 - \gamma) \left[u_2 - \frac{1}{2} u_1 - \frac{1}{2} u_3 \right] \geq 0 \end{aligned}$$

As $\gamma \rightarrow 1$:

$$u_2 \geq u_4$$

This must hold by the definition of the utility function. □

Definition 7. Reverse commitment equilibrium: Candidates who prefer C commit to C, candidates who prefer B/D commit to B/D, and candidates who prefer A/E commit to C. The median voter votes for a candidate who commits to B/D over a candidate who takes no position.

Proposition 14. In the limit as $\gamma \rightarrow 1$, the reverse commitment equilibrium exists if and only if the following conditions hold:

$$u_3 - \frac{1}{2} u_2 - \frac{1}{2} u_4 \geq 0 \tag{A.23}$$

$$\frac{1}{2}u_1 + \frac{1}{2}u_3 - u_2 \geq 0 \quad (\text{A.24})$$

$$u_2 \geq \pi_A u_3 + \pi_B u_2 + \pi_C u_1 \quad (\text{A.25})$$

Proof. The median voter prefers a candidate who commits to B/D over a candidate who takes no position; this is true if and only if equation A.25 holds. The equilibrium payoff of a candidate who prefers A/E is

$$\begin{aligned} & \pi_A \left[\gamma^2 u_3 + 2\gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_B \left[\gamma^2 u_3 + \gamma(1-\gamma)u_3 + \gamma(1-\gamma)u_4 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_C \left[\gamma^2 u_3 + 2\gamma(1-\gamma)u_3 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \end{aligned}$$

If he deviates to committing to B/D, his payoff is

$$\begin{aligned} & \pi_A \left[\gamma u_3 + \gamma(1-\gamma)u_2 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right] \\ & + \pi_B \left[\left(\frac{1}{2}\gamma^2 + \gamma(1-\gamma) \right) (u_2 + u_4) + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_4 \right) \right] \\ & + \pi_C \left[\gamma u_3 + \gamma(1-\gamma)u_2 + (1-\gamma)^2 \left(\frac{1}{2}u_1 + \frac{1}{2}u_3 \right) \right] \end{aligned}$$

He would *not* deviate if and only if

$$(1-\gamma)(u_3 - u_2) + \gamma\pi_B \left[u_3 - \frac{1}{2}u_2 - \frac{1}{2}u_4 \right] \geq 0$$

As $\gamma \rightarrow 1$:

$$u_3 - \frac{1}{2}u_2 - \frac{1}{2}u_4 \geq 0$$

This implies that the candidate must be risk-loving over policies in this range.

If instead he deviates to taking no position, his payoff is

$$\pi_A \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2}u_1 + \frac{1}{2}u_5 \right) \right]$$

$$\begin{aligned}
& +\pi_B \left[\gamma u_4 + (1-\gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right] \\
& +\pi_C \left[\gamma u_3 + (1-\gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right]
\end{aligned}$$

He would *not* deviate if and only if

$$\begin{aligned}
& (1-\gamma) \pi_A \left[u_3 - \frac{1}{2} u_1 - \frac{1}{2} u_5 \right] \\
& +\pi_B \left[u_3 - \frac{1}{2} (1+\gamma) u_4 - \frac{1}{2} (1-\gamma) u_1 \right] \\
& +\frac{1}{2} (1-\gamma) \pi_C [u_3 - u_1] \geq 0
\end{aligned}$$

As $\gamma \rightarrow 1$:

$$u_3 \geq u_4$$

This holds by definition of the utility function. The equilibrium payoff of a candidate who prefers B/D is

$$\begin{aligned}
& \pi_A \left[\gamma u_2 + \gamma (1-\gamma) u_1 + (1-\gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right] \\
& +\pi_B \left[\left(\frac{1}{2} \gamma^2 + \gamma (1-\gamma) \right) (u_1 + u_3) + (1-\gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right] \\
& +\pi_C \left[\gamma u_2 + \gamma (1-\gamma) u_1 + (1-\gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_2 \right) \right]
\end{aligned}$$

If he deviates to committing to C, his payoff is

$$\begin{aligned}
& \pi_A \left[\gamma^2 u_2 + \gamma (1-\gamma) u_2 + \gamma (1-\gamma) u_2 + (1-\gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right] \\
& +\pi_B \left[\gamma^2 u_2 + \gamma (1-\gamma) u_2 + \gamma (1-\gamma) u_3 + (1-\gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right] \\
& +\pi_C \left[\gamma^2 u_2 + \gamma (1-\gamma) u_2 + \gamma (1-\gamma) u_2 + (1-\gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_2 \right) \right]
\end{aligned}$$

He would *not* deviate if and only if

$$(1 - \gamma)[u_1 - u_2] + \gamma\pi_B \left[\frac{1}{2}u_1 + \frac{1}{2}u_3 - u_2 \right] \geq 0$$

As $\gamma \rightarrow 1$:

$$\frac{1}{2}u_1 + \frac{1}{2}u_3 - u_2 \geq 0$$

This implies that the candidate must be risk-averse over policies in this range. Therefore, the reverse commitment equilibrium does not exist if candidates have consistent risk preferences over policies. \square

Proposition 12. Suppose that candidates are risk-averse over policies. Then, in the limit as $\gamma \rightarrow 1$:

1. The centrist equilibrium is the unique pure-strategies equilibrium if and only if

$$u_2 \leq \pi_A u_3 + \pi_B u_2 + \pi_C u_1$$

2. The centrist-B equilibrium is the unique pure-strategies equilibrium if and only if

$$u_2 \geq \pi_A u_3 + \pi_B u_2 + \pi_C u_1$$

Proof. First, one must show that equilibria other than those discussed above do not exist. Suppose that an equilibrium exists in which candidates who prefer C commit to C, those who prefer B/D commit to B/D, those who prefer A/E take no position, and voters prefer a candidate who takes no position over one who commits to B/D. Suppose a candidate who prefers B/D deviates to taking no position. The policy implemented if elected doesn't change. His probability of winning against a candidate who prefers C is higher because he would now win if the centrist couldn't commit. Against a candidate who prefers B/D, he now wins when the other candidate is able to commit, and they split otherwise. Against a candidate who prefers A/E, he now splits, instead of losing when he was able to commit. Thus, the policy when he wins doesn't change and

his probability of winning increases; this is a profitable deviation. Thus, this equilibrium does not exist.

Suppose instead that an equilibrium exists in which candidates who prefer C commit to C, all other types take no position, and the median voter prefers a candidate who commits to B/D to one who takes no position. A candidate who prefers B/D would deviate to committing to B/D. By doing so, he would increase his probability of winning while implementing his most preferred policy if he wins. Therefore, this equilibrium does not exist.

Suppose that an equilibrium exists in which candidates who prefer C and B/D commit to C, candidates who prefer A/E take no position, and the median voter prefers a candidate who commits to B/D to one who takes no position. If a candidate who prefers B/D deviates to B/D, his expected payoff is

$$\begin{aligned} & \pi_A \left[\gamma u_1 + (1 - \gamma) \left(\frac{1}{2} u_1 + \frac{1}{2} u_4 \right) \right] \\ & + \pi_B \left[\gamma^2 u_2 + \gamma (1 - \gamma) u_1 + \gamma (1 - \gamma) u_2 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_3 \right) \right] \\ & + \pi_C \left[\gamma^2 u_2 + \gamma (1 - \gamma) u_1 + \gamma (1 - \gamma) u_2 + (1 - \gamma)^2 \left(\frac{1}{2} u_1 + \frac{1}{2} u_2 \right) \right] \end{aligned}$$

He would *not* choose to deviate if and only if

$$[\pi_A + \pi_B (1 - \gamma) + \pi_C (1 - \gamma)] [u_2 - u_1] > 0$$

This does not hold, so this equilibrium cannot exist.

Suppose that there exists an equilibrium in which candidates who prefer C commit to C, all other candidates commit to B/D, and the median voter prefers a candidate who takes no position to one who commits to B/D. If a candidate who preferred A/E deviated to taking no position, he would increase his winning probability, and he would be able to implement his preferred policy. Thus, he would deviate and this could not be an equilibrium.

Suppose that there exists an equilibrium in which candidates who prefer B/D or C commit to C, candidates who prefer A/E commit to B/D, and the median voter prefers a candidate who takes no position to one who commits to B/D. This implies that candidates who prefer A/E only win if they are unable to commit. They would improve their winning chances and implement the same policy if elected by simply taking no position. Thus, these candidates would deviate to taking no position and this cannot be an equilibrium.

Suppose that candidates who prefer C and A/E commit to C, candidates who prefer B/D commit to B/D, and the median voter prefers a candidate who takes no position to one who commits to B/D. A candidate who prefers B/D can deviate to taking no position. His payoff if his opponent commits to C would remain the same, but he would be able to have a chance of winning if his opponent is unable to commit or he faces an opponent who commits to B/D. Thus, this equilibrium does not exist.

Suppose that candidates are risk-averse. Equation A.8 requires that for the near-revelation equilibrium, $\frac{u_1 - u_2 - u_4}{u_2 - u_4} \geq \frac{\pi_A + \pi_B}{\pi_A}$. Risk aversion implies that $u_1 - u_2 < u_2 - u_3$, which further implies that $\frac{u_1 - u_2 - u_4}{u_2 - u_4} < \frac{u_2 - u_4 - u_3}{u_2 - u_4} = 1 - \frac{u_3}{u_2 - u_4}$. Since the right-hand side of equation A.8 is larger than 1, it cannot hold if the candidates are risk-averse. Equation A.10 requires $\frac{u_1 + u_3 - 2u_2}{u_3 - u_4} \geq \frac{\pi_A}{\pi_A + \pi_B}$ for the ambiguity equilibrium. $\frac{u_1 + u_3 - 2u_2}{u_3 - u_4} = \frac{u_1 - u_2 - (u_2 - u_3)}{u_3 - u_4} < 0$. Therefore, the ambiguity equilibrium does not exist. Equation A.13 requires that for the near-centrist equilibrium, $u_1 - 2u_3 \geq 0$. Risk aversion implies that $u_3 > \frac{1}{2}u_1 + \frac{1}{2}u_5 = u_3 > \frac{1}{2}u_1 \Leftrightarrow 2u_3 > u_1$. The near-centrist equilibrium also cannot exist. The commitment I equilibrium does not exist, since equation A.18 implies that by definition, the candidate must be risk-loving. As was established above, the commitment II and reverse commitment equilibria require that candidates be risk-loving over part of the policy space. Since these are all of the remaining possible equilibria in pure strategies, the centrist or centrist-B equilibrium is unique in the limit as $\gamma \rightarrow 1$. \square

APPENDIX B
APPENDIX TO CHAPTER 2

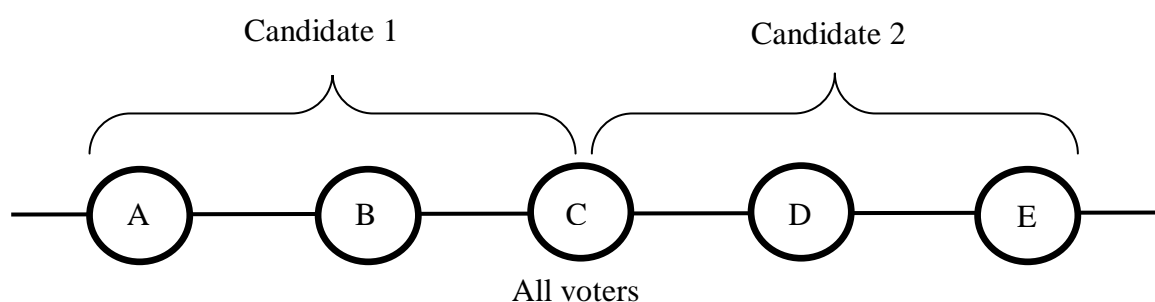
B.1 Experiment Materials

Instructions: Subject-Candidates, No Beliefs Treatment

In the main part of this experiment, you will play 3 sets of 5 rounds of an election game. Your payment depends on your decisions, so it is important that you understand the instructions and think carefully before you make your choices. If you have any questions after reading the instructions or during the experiment, please raise your hand.

In each round, the computer will randomly select two participants to be candidates, and the rest of the participants will be voters. The purpose of the election in each round is to elect a candidate who will select one of five policies: A, B, C, D, or E.

In each round, each player will be told his/her “preferred policy.” All voters prefer policy C. If you are chosen to be a candidate, you will be told your preferred policy, but only you will see that information. Neither the other candidate nor the voters will see this; however, everyone will be told how likely it is that the computer draws each possible preferred policy. These probabilities will vary across sets of rounds, but Candidate 1’s preferred policy is always either A, B, or C, and Candidate 2’s preferred policy is either C, D, or E.



Each player earns points depending on how close the policy implemented by the elected candidate is to his/her preferred policy. The payoff table (separate page) shows the points that a player would earn in a round, depending on his/her preferred policy and the policy chosen by the winning candidate. Please study this table carefully and keep it handy in case you need to refer back to it. One round will be selected randomly at the end of the experiment, and you will be paid in dollars the number of points that you earned in that round. All rounds are equally likely to be chosen, so you should play each round as if it determines your payment.

If you are a candidate, you are paid only based on the policy implemented; there is no bonus for winning the election. However, since you can only implement the policy you want and prevent the other candidate from choosing a different policy by winning the election, you also

Instructions: Subject-Candidates, No Beliefs Treatment

have an incentive to try to win the election. As a candidate, you must choose whether you would like to try to commit to a policy or take no position.

Next, the computer randomly determines whether each candidate who would like to commit to a policy is able to. In two sets of rounds, there is a 90% chance that a candidate will be able to successfully commit; in the other set, there is a 75% chance that each candidate can commit. You will be told what the chance is for each round.

If a candidate successfully commits to a policy, that policy is implemented if the candidate wins the election. If a candidate does not commit (either because he/she chose not to commit or because the computer determined that he/she was not able to commit), his/her preferred policy is implemented if he/she wins the election.

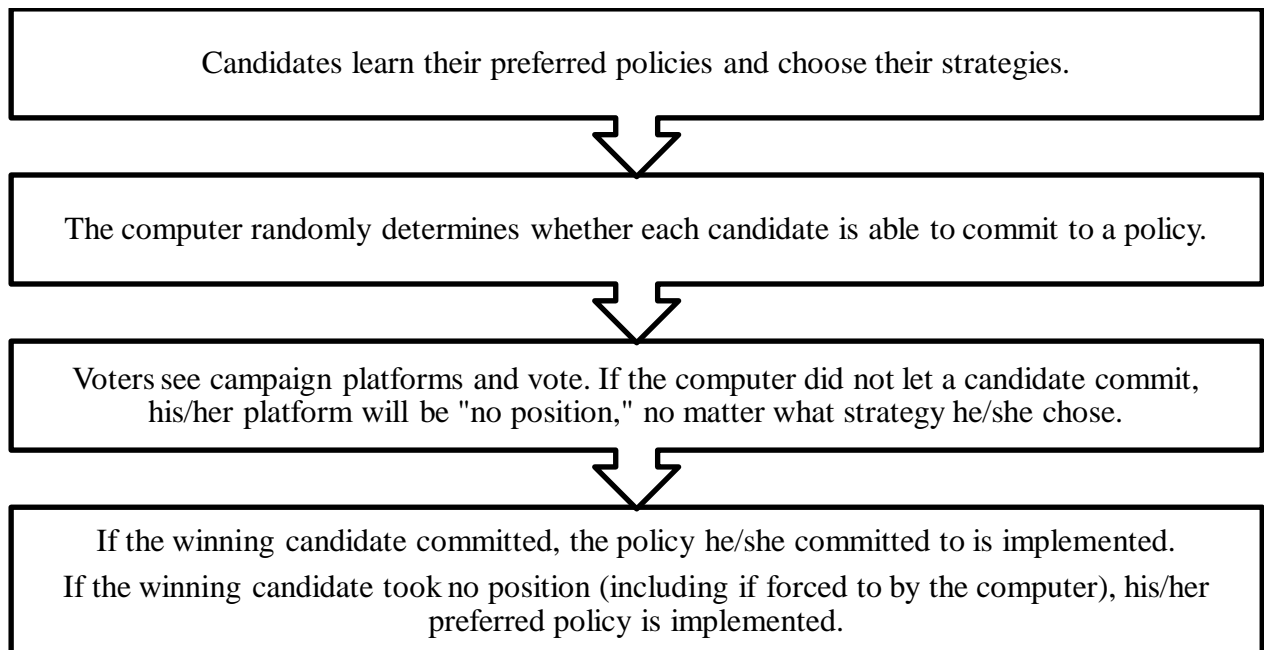
If you are a voter, you will be asked how you wish to vote, depending on which platforms are chosen by the candidates. Note that when you are asked about a candidate who took “no position,” this could be either because the candidate chose “no position” or because the computer randomly determined that he/she could not commit when he/she wanted to. If you like both candidates equally, you may choose to abstain, which means that you do not cast a vote for either candidate.

When everyone has voted, the votes will be counted and the candidate with the most votes wins the election. If both candidates receive the same number of votes, a winner is chosen randomly. The results screen will show each candidate’s platform, the number of votes for each candidate, the winner, the policy implemented, and the number of points you earned in that round.

To understand how this works, consider the following example. Suppose that Candidate 1 commits to policy B and Candidate 2 takes no position. If Candidate 1 wins, the voters each receive 4 points. If Candidate 2 is elected, the number of points earned is uncertain: voters earn 10 points if Candidate 2 prefers C, 4 points if he/she prefers B or D, and 2 points if he/she prefers A or E.

Instructions: Subject-Candidates, No Beliefs Treatment

The figure below summarizes what will happen in each round:



You will now play 5 practice rounds, to help you understand how the experiment works. Your payment will not depend on your play in these rounds. You will have 3 minutes to make a decision on each screen. The amount of time remaining (in seconds) will be displayed in the upper right corner of your screen. When you have made your decision, click the button in the lower right corner of the screen to submit your choice and continue.

Note that there is a box at the top of the screen that tells you how likely it is that a candidate has each preferred policy and how likely it is that the computer will prevent a candidate from committing to a policy when he/she wants to. In the actual experiment, this information will change after each set of 5 rounds, so it is very important that you read this box before making your decisions.

On decision screens, a calculator icon will appear at the bottom of the screen. If you would like to use the calculator, just click on the icon. Note that the calculator does not use the order of operations automatically, so you must use parentheses to make sure that it does calculations that require more than one operation correctly.

Instructions: Subject-Candidates, No Beliefs Treatment

In the practice rounds, you were told which campaign platforms were taken by each candidate before you cast your votes. In the actual experiment, if you are a voter, you will be asked about which candidate you would vote for in all possible situations. Since each candidate has four possible campaign platforms, there are 16 possible combinations. For example, you will be asked who you would vote for if Candidate 1 commits to A and Candidate 2 commits to E; if Candidate 1 commits to A and Candidate 2 commits to D; and so on. The computer will then use the choices that correspond to the strategies that are actually chosen by the candidates in that round when it counts the votes. If you do not make all 16 voting decisions, you will earn zero points for the round and your vote will not be counted.

If one candidate does not make a choice before time is up, he/she forfeits the election and his/her opponent wins. If both candidates do not make a choice before time is up, the computer will randomly choose a winner. If you do not make a decision as a candidate, you will earn zero points for the round.

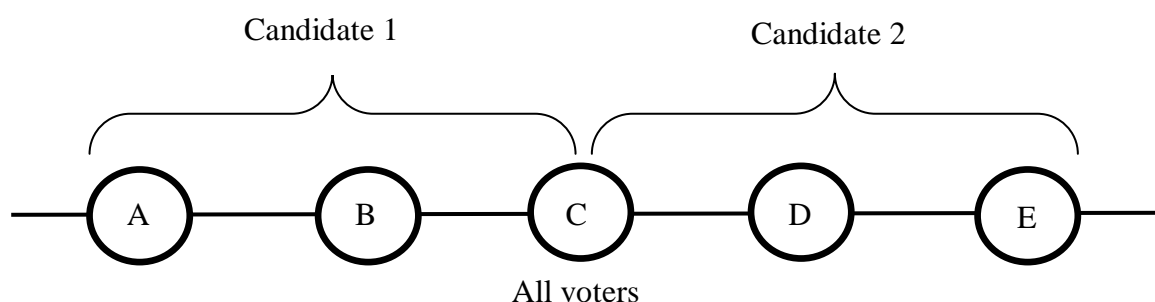
The election rounds will now begin. You will receive additional instructions after the election game.

Instructions: Subject-Candidates, With Beliefs Treatment

In the main part of this experiment, you will play 3 sets of 5 rounds of an election game. Your payment depends on your decisions, so it is important that you understand the instructions and think carefully before you make your choices. If you have any questions after reading the instructions or during the experiment, please raise your hand.

In each round, the computer will randomly select two participants to be candidates, and the rest of the participants will be voters. The purpose of the election in each round is to elect a candidate who will select one of five policies: A, B, C, D, or E.

In each round, each player will be told his/her “preferred policy.” All voters prefer policy C. If you are chosen to be a candidate, you will be told your preferred policy, but only you will see that information. Neither the other candidate nor the voters will see this; however, everyone will be told how likely it is that the computer draws each possible preferred policy. These probabilities will vary across sets of rounds, but Candidate 1’s preferred policy is always either A, B, or C, and Candidate 2’s preferred policy is either C, D, or E.



Each player earns points depending on how close the policy implemented by the elected candidate is to his/her preferred policy. The payoff table (separate page) shows the points that a player would earn in a round, depending on his/her preferred policy and the policy chosen by the winning candidate. Please study this table carefully and keep it handy in case you need to refer back to it. One round will be selected randomly at the end of the experiment, and you will be paid in dollars the number of points that you earned in that round. All rounds are equally likely to be chosen, so you should play each round as if it determines your payment.

If you are a candidate, you are paid only based on the policy implemented; there is no bonus for winning the election. However, since you can only implement the policy you want and prevent the other candidate from choosing a different policy by winning the election, you also

Instructions: Subject-Candidates, With Beliefs Treatment

have an incentive to try to win the election. As a candidate, you must choose whether you would like to try to commit to a policy or take no position.

Next, the computer randomly determines whether each candidate who would like to commit to a policy is able to. In two sets of rounds, there is a 90% chance that a candidate will be able to successfully commit; in the other set, there is a 75% chance that each candidate can commit. You will be told what the chance is for each round.

If a candidate successfully commits to a policy, that policy is implemented if the candidate wins the election. If a candidate does not commit (either because he/she chose not to commit or because the computer determined that he/she was not able to commit), his/her preferred policy is implemented if he/she wins the election.

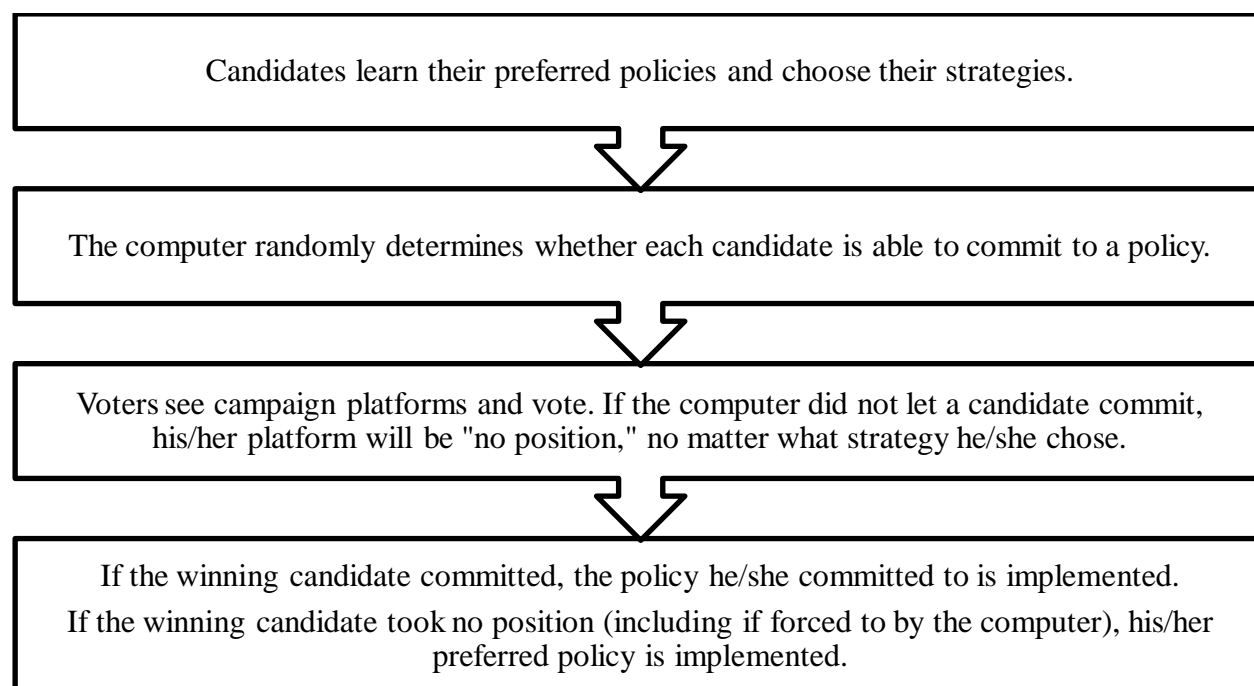
If you are a voter, you will be asked how you wish to vote, depending on which platforms are chosen by the candidates. Note that when you are asked about a candidate who took “no position,” this could be either because the candidate chose “no position” or because the computer randomly determined that he/she could not commit when he/she wanted to. If you like both candidates equally, you may choose to abstain, which means that you do not cast a vote for either candidate.

When everyone has voted, the votes will be counted and the candidate with the most votes wins the election. If both candidates receive the same number of votes, a winner is chosen randomly. The results screen will show each candidate’s platform, the number of votes for each candidate, the winner, the policy implemented, and the number of points you earned in that round.

To understand how this works, consider the following example. Suppose that Candidate 1 commits to policy B and Candidate 2 takes no position. If Candidate 1 wins, the voters each receive 4 points. If Candidate 2 is elected, the number of points earned is uncertain: voters earn 10 points if Candidate 2 prefers C, 4 points if he/she prefers B or D, and 2 points if he/she prefers A or E.

Instructions: Subject-Candidates, With Beliefs Treatment

The figure below summarizes what will happen in each round:



You will now play 5 practice rounds, to help you understand how the experiment works. Your payment will not depend on your play in these rounds. You will have 3 minutes to make a decision on each screen. The amount of time remaining (in seconds) will be displayed in the upper right corner of your screen. When you have made your decision, click the button in the lower right corner of the screen to submit your choice and continue.

Note that there is a box at the top of the screen that tells you how likely it is that a candidate has each preferred policy and how likely it is that the computer will prevent a candidate from committing to a policy when he/she wants to. In the actual experiment, this information will change after each set of 5 rounds, so it is very important that you read this box before making your decisions.

On decision screens, a calculator icon will appear at the bottom of the screen. If you would like to use the calculator, just click on the icon. Note that the calculator does not use the order of operations automatically, so you must use parentheses to make sure that it does calculations that require more than one operation correctly.

Instructions: Subject-Candidates, With Beliefs Treatment

In the practice rounds, you were told which campaign platforms were taken by each candidate before you cast your votes. In the actual experiment, if you are a voter, you will be asked about which candidate you would vote for in all possible situations. Since each candidate has four possible campaign platforms, there are 16 possible combinations. For example, you will be asked who you would vote for if Candidate 1 commits to A and Candidate 2 commits to E; if Candidate 1 commits to A and Candidate 2 commits to D; and so on. The computer will then use the choices that correspond to the strategies that are actually chosen by the candidates in that round when it counts the votes. If you do not make all 16 voting decisions, you will earn zero points for the round and your vote will not be counted.

If one candidate does not make a choice before time is up, he/she forfeits the election and his/her opponent wins. If both candidates do not make a choice before time is up, the computer will randomly choose a winner. If you do not make a decision as a candidate, you will earn zero points for the round.

Finally, before each round in which you are a voter, you will be asked two sets of belief questions. First, you will be asked which strategy you think each candidate will choose, depending on his/her preferred policy. Recall that the strategy is what the candidate chooses to do. If a candidate chooses to commit to C and the computer randomly does not allow him/her to, his/her strategy was still to commit to C. Using the radio buttons at the top of the screen, you may choose to answer these questions in one of two ways. You may answer the questions by moving 4 sliders, one for each possible campaign strategy. The more likely you think it is that the candidate will choose that strategy, given his/her preferred policy, the further to the right you should place the slider. Based on where you place the sliders relative to each other, the computer will calculate probabilities, which are updated as you move the sliders. You may also choose to enter probabilities directly. If you choose this option, you must enter probabilities that add up to 100.

Next, you will be asked about what you think of candidates who do not take a position. You will answer the questions by moving 3 sliders (or entering 3 probabilities), one for each possible preferred policy. You will have 3 minutes to complete each screen, and you must click the button in order to record your answers.

Instructions: Subject-Candidates, With Beliefs Treatment

In each round, you will be entered into up to 4 lotteries. The first two correspond to the first set of belief questions. Your chance of winning the first lottery depends on your answers about Candidate 1's strategy, given the preferred policy Candidate 1 had, and your chance of winning the second lottery depends on your answers about Candidate 2's strategy, given the preferred policy Candidate 2 had. The second two correspond to the second set of belief questions. Your chance of winning the third lottery depends on your answers about Candidate 1's preferred policy given that he/she took no position, and your chance of winning the fourth lottery depends on your answers about Candidate 2's preferred policy given that he/she took no position. You will be entered into the third lottery only if Candidate 1's platform was "no position," and you will be entered into the fourth lottery only if Candidate 2's platform was "no position." The more accurate your beliefs are, the higher your chance of winning the lottery will be. Your payment for this task will be the percentage of entered lotteries that you won multiplied by \$3.

The equations at the end of these instructions tell you exactly how your probability of winning is calculated for each lottery, though all you need to know is that the best way to earn as much as possible is to truthfully report what you think.

Before you begin the election game, there will be a screen that gives you an opportunity to practice answering questions about probabilities. The election game will begin after everyone has completed this practice screen. You will receive additional instructions after the election game.

For the questions about Candidate 1's strategy if his/her preferred policy is A, let s_k be equal to 1 if Candidate 1 chooses campaign strategy k and 0 otherwise. Let p_k be the answer you gave for the probability that Candidate 1 chose campaign strategy k given that his/her preferred policy was A. Your probability of winning the lottery is:

$$1 - \frac{1}{2}(s_A - p_A)^2 - \frac{1}{2}(s_B - p_B)^2 - \frac{1}{2}(s_C - p_C)^2 - \frac{1}{2}(s_{no\ position} - p_{no\ position})^2$$

The formulas for beliefs about Candidate 1's strategy given other preferred policies and about Candidate 2's strategies are constructed in the same way.

Instructions: Subject-Candidates, With Beliefs Treatment

For the second set of questions, let π_j be equal to 1 if Candidate 1's preferred policy is j and 0 otherwise. Let r_j be the answer you gave for the probability that Candidate 1's preferred policy is j . Your probability of winning the lottery is:

$$1 - \frac{1}{2}(\pi_A - r_A)^2 - \frac{1}{2}(\pi_B - r_B)^2 - \frac{1}{2}(\pi_C - r_C)^2$$

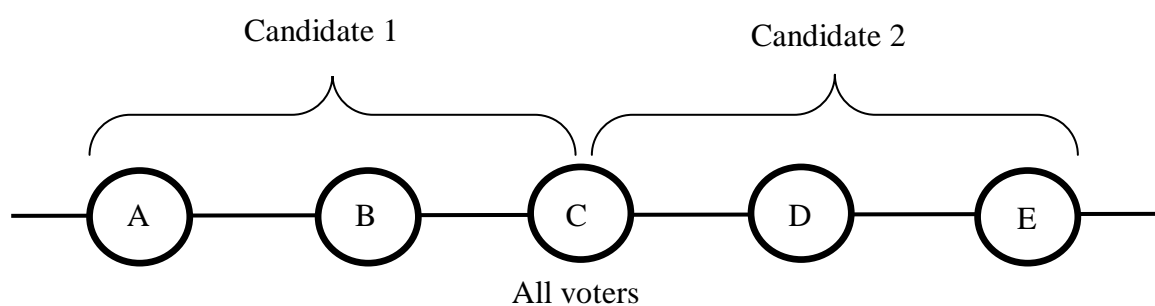
The formula for beliefs about Candidate 2 is constructed in the same way.

Instructions: Programmed Candidates Treatment

In the main part of this experiment, you will play 3 sets of 5 rounds of an election game. Your payment depends on your decisions, so it is important that you understand the instructions and think carefully before you make your choices. If you have any questions after reading the instructions or during the experiment, please raise your hand.

In each round, the computer will play the roles of two candidates, and each participant will be a voter. The purpose of the election in each round is to elect a candidate who will select one of five policies: A, B, C, D, or E.

All voters prefer policy C. Voters do not know the preferred policy of each candidate, but they will be told how likely it is that the computer draws each possible preferred policy. These probabilities will vary across sets of rounds, but Candidate 1's preferred policy is always either A, B, or C, and Candidate 2's preferred policy is either C, D, or E.



Each player earns points depending on how close the policy implemented by the elected candidate is to his/her preferred policy. The payoff table (separate page) shows the points that a player would earn in a round, depending on his/her preferred policy and the policy chosen by the winning candidate. Please study this table carefully and keep it handy in case you need to refer back to it. One round will be selected randomly at the end of the experiment, and you will be paid in dollars the number of points that you earned in that round. All rounds are equally likely to be chosen, so you should play each round as if it determines your payment.

Each candidate is programmed to choose the campaign strategies that would maximize its expected payoff, assuming everyone else is also maximizing their own expected payoffs. When thinking about what the candidates will do, you should understand that each candidate behaves as if it is paid only based on the policy implemented; there is no bonus for winning the election. However, since a candidate can only implement the policy it wants and prevent the other candidate from choosing a different policy by winning the election, it also has an incentive to try

Instructions: Programmed Candidates Treatment

to win the election. Each candidate must choose whether it would like to try to commit to a policy or take no position.

Next, the computer randomly determines whether each candidate who would like to commit to a policy is able to. In two sets of rounds, there is a 90% chance that a candidate will be able to successfully commit; in the other set, there is a 75% chance that each candidate can commit. You will be told what the chance is for each round.

If a candidate successfully commits to a policy, that policy is implemented if the candidate wins the election. If a candidate does not commit (either because he/she chose not to commit or because the computer determined that he/she was not able to commit), his/her preferred policy is implemented if he/she wins the election.

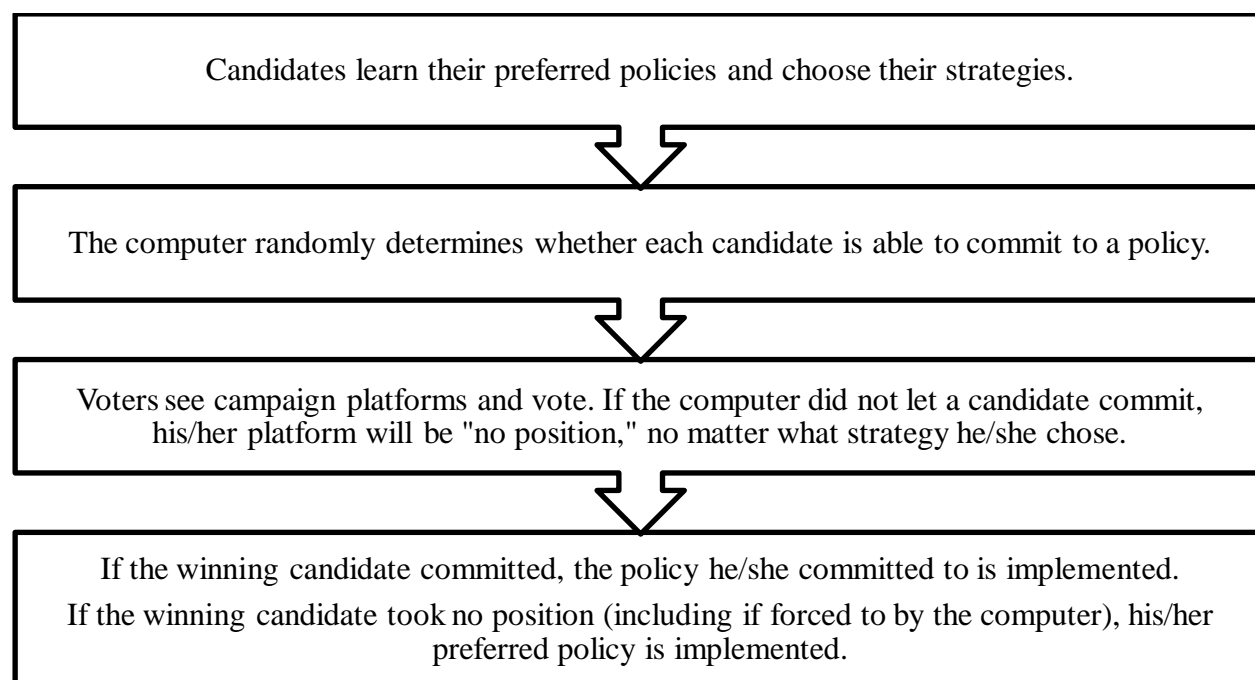
You will be asked how you wish to vote, depending on which platforms are chosen by the candidates. Note that when you are asked about a candidate who took “no position,” this could be either because the candidate chose “no position” or because the computer randomly determined that he/she could not commit when he/she wanted to. If you like both candidates equally, you may choose to abstain, which means that you do not cast a vote for either candidate.

When everyone has voted, the votes will be counted and the candidate with the most votes wins the election. If both candidates receive the same number of votes, a winner is chosen randomly. The results screen will show each candidate’s platform, the number of votes for each candidate, the winner, the policy implemented, and the number of points you earned in that round.

To understand how this works, consider the following example. Suppose that Candidate 1 commits to policy B and Candidate 2 takes no position. If Candidate 1 wins, the voters each receive 4 points. If Candidate 2 is elected, the number of points earned is uncertain: voters earn 10 points if Candidate 2 prefers C, 4 points if he/she prefers B or D, and 2 points if he/she prefers A or E.

Instructions: Programmed Candidates Treatment

The figure below summarizes what will happen in each round:



You will now play 5 practice rounds, to help you understand how the experiment works. Your payment will not depend on your play in these rounds. You will have 3 minutes to make a decision on each screen. The amount of time remaining (in seconds) will be displayed in the upper right corner of your screen. When you have made your decision, click the button in the lower right corner of the screen to submit your choice and continue.

Note that there is a box at the top of the screen that tells you how likely it is that a candidate has each preferred policy and how likely it is that the computer will prevent a candidate from committing to a policy when he/she wants to. In the actual experiment, this information will change after each set of 5 rounds, so it is very important that you read this box before making your decisions.

On decision screens, a calculator icon will appear at the bottom of the screen. If you would like to use the calculator, just click on the icon. Note that the calculator does not use the order of operations automatically, so you must use parentheses to make sure that it does calculations that require more than one operation correctly.

Instructions: Programmed Candidates Treatment

In the practice rounds, you were told which campaign platforms were taken by each candidate before you cast your votes. In the actual experiment, you will be asked about which candidate you would vote for in all possible situations. Since each candidate has four possible campaign platforms, there are 16 possible combinations. For example, you will be asked who you would vote for if Candidate 1 commits to A and Candidate 2 commits to E; if Candidate 1 commits to A and Candidate 2 commits to D; and so on. The computer will then use the choices that correspond to the strategies that are actually chosen by the candidates in that round when it counts the votes. If you do not make all 16 voting decisions, you will earn zero points for the round and your vote will not be counted.

Finally, before each round, you will be asked two sets of belief questions. First, you will be asked which strategy you think each candidate will choose, depending on his/her preferred policy. Recall that the strategy is what the candidate chooses to do. If a candidate chooses to commit to C and the computer randomly does not allow him/her to, his/her strategy was still to commit to C. Using the radio buttons at the top of the screen, you may choose to answer these questions in one of two ways. You may answer the questions by moving 4 sliders, one for each possible campaign strategy. The more likely you think it is that the candidate will choose that strategy, given his/her preferred policy, the further to the right you should place the slider. Based on where you place the sliders relative to each other, the computer will calculate probabilities, which are updated as you move the sliders. You may also choose to enter probabilities directly. If you choose this option, you must enter probabilities that add up to 100.

Next, you will be asked about what you think of candidates who do not take a position. You will answer the questions by moving 3 sliders (or entering 3 probabilities), one for each possible preferred policy. You will have 3 minutes to complete each screen, and you must click the button in order to record your answers.

In each round, you will be entered into up to 4 lotteries. The first two correspond to the first set of belief questions. Your chance of winning the first lottery depends on your answers about Candidate 1's strategy, given the preferred policy Candidate 1 had, and your chance of winning the second lottery depends on your answers about Candidate 2's strategy, given the preferred policy Candidate 2 had. The second two correspond to the second set of belief questions. Your chance of winning the third lottery depends on your answers about Candidate 1's preferred policy given that he/she took no position, and your chance of winning the fourth

Instructions: Programmed Candidates Treatment

lottery depends on your answers about Candidate 2's preferred policy given that he/she took no position. You will be entered into the third lottery only if Candidate 1's platform was "no position," and you will be entered into the fourth lottery only if Candidate 2's platform was "no position." The more accurate your beliefs are, the higher your chance of winning the lottery will be. Your payment for this task will be the percentage of entered lotteries that you won multiplied by \$3.

The equations at the end of these instructions tell you exactly how your probability of winning is calculated for each lottery, though all you need to know is that the best way to earn as much as possible is to truthfully report what you think.

Before you begin the election game, there will be a screen that gives you an opportunity to practice answering questions about probabilities. The election game will begin after everyone has completed this practice screen. You will receive additional instructions after the election game.

For the questions about Candidate 1's strategy if his/her preferred policy is A, let s_k be equal to 1 if Candidate 1 chooses campaign strategy k and 0 otherwise. Let p_k be the answer you gave for the probability that Candidate 1 chose campaign strategy k given that his/her preferred policy was A. Your probability of winning the lottery is:

$$1 - \frac{1}{2}(s_A - p_A)^2 - \frac{1}{2}(s_B - p_B)^2 - \frac{1}{2}(s_C - p_C)^2 - \frac{1}{2}(s_{no\ position} - p_{no\ position})^2$$

The formulas for beliefs about Candidate 1's strategy given other preferred policies and about Candidate 2's strategies are constructed in the same way.

For the second set of questions, let π_j be equal to 1 if Candidate 1's preferred policy is j and 0 otherwise. Let r_j be the answer you gave for the probability that Candidate 1's preferred policy is j . Your probability of winning the lottery is:

$$1 - \frac{1}{2}(\pi_A - r_A)^2 - \frac{1}{2}(\pi_B - r_B)^2 - \frac{1}{2}(\pi_C - r_C)^2$$

The formula for beliefs about Candidate 2 is constructed in the same way.

Payoff table, included with instructions for all treatments

		Policy chosen by the winner of the election				
		A	B	C	D	E
Preferred Policy	A	10	4	2	1	0
	B	4	10	4	2	1
	C	2	4	10	4	2
	D	1	2	4	10	4
	E	0	1	2	4	10

Instructions for Bayes' Rule task: treatment with no beliefs

This task is designed to test your understanding of probabilities. It is based on the election game that you just played. As before, there will be a box at the top of the screen that tells you how likely it is that the candidates will have each possible preferred policy and how likely it is that the computer will prevent a candidate from making a policy commitment. On each of the following screens, you will see a table on the left side of the screen that tells you what Candidate 1 has decided to do, depending on what his/her preferred policy is. Now, suppose that Candidate 1 takes no position; as before, this could be because he/she chose "no position" or because the computer did not allow him/her to commit. Based on this information, your job is to determine how likely it is that his/her preferred policy is A, B, or C.

Using the radio buttons at the top of the screen, you may choose to answer these questions in one of two ways. You may answer the questions by moving 3 sliders, one for each possible preferred policy. The more likely you think it is that Candidate 1 has that preferred policy, the further to the right you should place the slider. Based on where you place the sliders relative to each other, the computer will calculate probabilities, which are updated as you move the sliders. You may also choose to enter probabilities directly. If you choose this option, you must enter probabilities that add up to 100. You will have 3 minutes on each screen, and you must click the button in order to record your answers.

There will be a total of 6 screens for this task. There is a lottery associated with each screen. The better you do on this task, the higher your chance of winning the lottery will be. If you do not answer the questions on a screen, you will lose the lottery for that screen. Your payment for this task will be your winning percentage in these lotteries multiplied by \$2.

The equation at the end of these instructions tells you exactly how your probability of winning is calculated for each screen, though all you need to know is that the best way to earn as much as possible is to truthfully report what you think.

Before this task begins, there will be a screen that gives you an opportunity to practice answering questions about probabilities.

After you have answered the questions described above, you will complete two short tasks. The instructions for these will appear on the screen. Please read them carefully. When everyone is finished, there will be a short demographic questionnaire to end the experiment.

Instructions for Bayes' Rule task: treatment with no beliefs

Let π_j be the actual probability that Candidate 1's preferred policy is j , given that he/she has taken no position. Let r_j be the answer you gave about what you think π_j is. Your probability of winning the lottery is:

$$1 - \frac{1}{2}(\pi_A - r_A)^2 - \frac{1}{2}(\pi_B - r_B)^2 - \frac{1}{2}(\pi_C - r_C)^2$$

Instructions for Bayes' Rule task: treatments with beliefs

This task is designed to test your understanding of probabilities. It is based on the election game that you just played. As before, there will be a box at the top of the screen that tells you how likely it is that the candidates will have each possible preferred policy and how likely it is that the computer will prevent a candidate from making a policy commitment. On each of the following screens, you will see a table on the left side of the screen that tells you what Candidate 1 has decided to do, depending on what his/her preferred policy is. Now, suppose that Candidate 1 takes no position; as before, this could be because he/she chose “no position” or because the computer did not allow him/her to commit. Based on this information, your job is to determine how likely it is that his/her preferred policy is A, B, or C.

Using the radio buttons at the top of the screen, you may choose to answer these questions in one of two ways. You may answer the questions by moving 3 sliders, one for each possible preferred policy. The more likely you think it is that Candidate 1 has that preferred policy, the further to the right you should place the slider. Based on where you place the sliders relative to each other, the computer will calculate probabilities, which are updated as you move the sliders. You may also choose to enter probabilities directly. If you choose this option, you must enter probabilities that add up to 100. You will have 3 minutes on each screen, and you must click the button in order to record your answers.

There will be a total of 6 screens for this task. There is a lottery associated with each screen. The better you do on this task, the higher your chance of winning the lottery will be. If you do not answer the questions on a screen, you will lose the lottery for that screen. Your payment for this task will be your winning percentage in these lotteries multiplied by \$2.

The equation at the end of these instructions tells you exactly how your probability of winning is calculated for each screen, though all you need to know is that the best way to earn as much as possible is to truthfully report what you think.

After you have answered the questions described above, you will complete two short tasks. The instructions for these will appear on the screen. Please read them carefully. When everyone is finished, there will be a short demographic questionnaire to end the experiment.

Let π_j be the actual probability that Candidate 1's preferred policy is j , given that he/she has taken no position. Let r_j be the answer you gave about what you think π_j is. Your probability of winning the lottery is:

Instructions for Bayes' Rule task: treatments with beliefs

$$1 - \frac{1}{2}(\pi_A - r_A)^2 - \frac{1}{2}(\pi_B - r_B)^2 - \frac{1}{2}(\pi_C - r_C)^2$$

Experiment Screenshots

Treatment with No Beliefs

First screen voters see in each practice period:

Period

Practice1 of 5

Remaining time [sec]: 42

You have been randomly assigned the role of a voter for this round.

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.

There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Please click the button to begin.

OK

First screen a candidate sees in each practice period:

Period

Practice1 of 5

Remaining time [sec]: 24

You have been randomly assigned the role of Candidate 2 for this round.

Your preferred policy is **D**.

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.

There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Please click the button to begin.

OK

Experiment Screenshots

Second screen voters see in each practice period:

Period

Practice1 of 5

Remaining time [sec]: 76

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Candidate 1	Candidate 2	Vote
no position	no position	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain

OK

Second screen candidates see in each practice period:

Period

Practice1 of 5

Remaining time [sec]: 157

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

You have been randomly chosen to be Candidate 2 for this round.

Your preferred policy is D

You will receive 1 point if policy A is implemented, 2 points if policy B is implemented, 4 points if policy C is implemented, 10 points if policy D is implemented, and 4 points if policy E is implemented.

Which campaign strategy do you choose?

☐ E
☒ D
☐ C
☐ no position

OK

Experiment Screenshots

Third and last screen in each practice period:

Period
Practice 1 of 5
Remaining time [sec]: 53

Candidate 1's platform: no position
Candidate 2's platform: no position
Number of votes for Candidate 1: 1
Number of votes for Candidate 2: 1
Winner: Candidate 2
Policy implemented: E
Points earned this round: 2

Continue

After 5 practice periods, additional instructions are read (beginning with “In the practice rounds...”).

Next, the real election periods start. First screen for a voter in each period:

Period
1 of 5
Remaining time [sec]: 54

You have been randomly assigned the role of a voter for this round.

There is a $\frac{1}{3}$ chance that Candidate 1's preferred policy is **A**, a $\frac{1}{3}$ chance that his/her preferred policy is **B**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.
There is a $\frac{1}{3}$ chance that Candidate 2's preferred policy is **E**, a $\frac{1}{3}$ chance that his/her preferred policy is **D**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Please click the button to begin.

OK

Experiment Screenshots

First screen for a candidate in each period:

Period

1 of 5

Remaining time [sec]: 27

You have been randomly assigned the role of Candidate 1 for this round.

Your preferred policy is **C**.

There is a $\frac{1}{3}$ chance that Candidate 1's preferred policy is **A**, a $\frac{1}{3}$ chance that his/her preferred policy is **B**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.

There is a $\frac{1}{3}$ chance that Candidate 2's preferred policy is **E**, a $\frac{1}{3}$ chance that his/her preferred policy is **D**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Please click the button to begin.

OK

Decision screen seen by each candidate:

Period

1 of 5

Remaining time [sec]: 168

There is a $\frac{1}{3}$ chance that Candidate 1's preferred policy is **A**, a $\frac{1}{3}$ chance that his/her preferred policy is **B**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.

There is a $\frac{1}{3}$ chance that Candidate 2's preferred policy is **E**, a $\frac{1}{3}$ chance that his/her preferred policy is **D**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

You have been randomly chosen to be Candidate 1 for this round.

Your preferred policy is **C**

You will receive 2 points if policy A is implemented, 4 points if policy B is implemented, 10 points if policy C is implemented, 4 points if policy D is implemented, and 2 points if policy E is implemented.


Which campaign strategy do you choose?

☐ A

☐ B

☒ C

☐ no position



OK

Experiment Screenshots

Voting screen:


Period

1 of 5

Remaining time [sec]: 147

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Candidate 1	Candidate 2	Vote	Candidate 1	Candidate 2	Vote
C	D	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	C	no position	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain
no position	D	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain	C	C	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain
B	D	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain	A	D	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain
A	C	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain	no position	C	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain
A	no position	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain	A	E	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain
B	no position	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	B	C	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain
C	E	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	B	E	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain
no position	E	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	no position	no position	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain



OK

Results screen, which is the last screen for each period:

Period

1 of 5

Remaining time [sec]: 54

Candidate 1's platform: B

Candidate 2's platform: no position

Number of votes for Candidate 1: 3

Number of votes for Candidate 2: 0

Winner: Candidate 1

Policy implemented: B

Points earned this round: 4

Continue

Experiment Screenshots

Treatment with Subject-Candidates with Beliefs

First screen voters see in each practice period:

Period

Practice1 of 5

Remaining time [sec]: 42

You have been randomly assigned the role of a voter for this round.

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.

There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Please click the button to begin.

OK

First screen a candidate sees in each practice period:

Period

Practice1 of 5

Remaining time [sec]: 24

You have been randomly assigned the role of Candidate 2 for this round.

Your preferred policy is **D**.

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.

There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Please click the button to begin.

OK

Experiment Screenshots

Second screen voters see in each practice period:


Period

Practice1 of 5

Remaining time [sec]: 76

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Candidate 1	Candidate 2	Vote
no position	no position	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain



OK

Second screen candidates see in each practice period:

Period

Practice1 of 5

Remaining time [sec]: 157

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."


You have been randomly chosen to be Candidate 2 for this round.

Your preferred policy is D

You will receive 1 point if policy A is implemented, 2 points if policy B is implemented, 4 points if policy C is implemented, 10 points if policy D is implemented, and 4 points if policy E is implemented.

Which campaign strategy do you choose?

☐ E
☒ D
☐ C
☐ no position



OK

Experiment Screenshots

Third and last screen in each practice period:

Period

Practice 1 of 5

Remaining time [sec]: 53

Candidate 1's platform: no position

Candidate 2's platform: no position

Number of votes for Candidate 1: 1

Number of votes for Candidate 2: 1

Winner: Candidate 2

Policy implemented: E

Points earned this round: 2

Continue

After 5 practice periods, there is a screen for practicing answering belief questions. Here is what it looks like if the subject chooses to use the sliders:

Remaining time [sec]: 116

How would you like to answer these questions?

☒ Use sliders

☐ Enter numbers

When two coins are flipped independently, the probability of getting two heads is 1/4, the probability of getting two tails is 1/4, and the probability of getting one head and one tail is 1/2. Please show this either by using the sliders or by entering numbers.

All three outcomes are equally likely. Please show this either by using the sliders or by entering numbers.

Outcome		Probability (%)	Outcome		Probability (%)
Two heads	Not possible Definitely	25	X	Not possible Definitely	33
Two tails	Not possible Definitely	25	Y	Not possible Definitely	34
One head and one tail	Not possible Definitely	50	Z	Not possible Definitely	33

OK

Experiment Screenshots

Here is that same screen if he/she chooses to enter probabilities directly:


Remaining time [sec]: 76

How would you like to answer these questions? ☐ Use sliders ☒ Enter numbers

When two coins are flipped independently, the probability of getting two heads is $\frac{1}{4}$, the probability of getting two tails is $\frac{1}{4}$, and the probability of getting one head and one tail is $\frac{1}{2}$. Please show this either by using the sliders or by entering numbers.

All three outcomes are equally likely. Please show this either by using the sliders or by entering numbers.

Outcome	Probability (%)	Outcome	Probability (%)
Two heads	25	X	33
Two tails	25	Y	33
One head and one tail	50	Z	33



OK

Next, the actual election periods start. First screen for a voter in each period:

Period 1 of 5

Remaining time [sec]: 54

You have been randomly assigned the role of a voter for this round.

There is a $\frac{1}{3}$ chance that Candidate 1's preferred policy is **A**, a $\frac{1}{3}$ chance that his/her preferred policy is **B**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.

There is a $\frac{1}{3}$ chance that Candidate 2's preferred policy is **E**, a $\frac{1}{3}$ chance that his/her preferred policy is **D**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Please click the button to begin.

OK

Experiment Screenshots

First screen for a candidate in each period:

Period

1 of 5

Remaining time [sec]: 27

You have been randomly assigned the role of Candidate 1 for this round.

Your preferred policy is **C**.

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.

There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Please click the button to begin.

OK

Decision screen seen by each candidate:

Period

1 of 5

Remaining time [sec]: 168

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.

There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

You have been randomly chosen to be Candidate 1 for this round.

Your preferred policy is **C**

You will receive 2 points if policy A is implemented, 4 points if policy B is implemented, 10 points if policy C is implemented, 4 points if policy D is implemented, and 2 points if policy E is implemented.


Which campaign strategy do you choose?

☐ A

☐ B

☒ C

☐ no position



OK

Experiment Screenshots

Screen from the first belief task (done by voters), with the slider option selected:

Period: 1 of 5 Remaining time [sec]: 166

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."


How would you like to answer these questions? ☒ Use sliders ☐ Enter numbers

If Candidate 1's preferred policy is **C**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy	Not possible	Definitely	Probability (%)
A	<input type="range"/>	<input type="range"/>	0
B	<input type="range"/>	<input type="range"/>	0
C	<input type="range"/>	<input type="range"/>	100
no position	<input type="range"/>	<input type="range"/>	0

If Candidate 2's preferred policy is **C**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy	Not possible	Definitely	Probability (%)
E	<input type="range"/>	<input type="range"/>	0
D	<input type="range"/>	<input type="range"/>	0
C	<input type="range"/>	<input type="range"/>	100
no position	<input type="range"/>	<input type="range"/>	0

 OK

Another screen from the first belief task (done by voters), with the “enter numbers” option selected.

Period: 1 of 5 Remaining time [sec]: 167

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."


How would you like to answer these questions? ☐ Use sliders ☒ Enter numbers

If Candidate 1's preferred policy is **B**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy	Probability (%)
A	<input type="text"/>
B	<input type="text" value="100"/>
C	<input type="text"/>
no position	<input type="text"/>

If Candidate 2's preferred policy is **D**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy	Probability (%)
E	<input type="text"/>
D	<input type="text" value="100"/>
C	<input type="text"/>
no position	<input type="text"/>

 OK

Experiment Screenshots

Third and final screen for the first belief task (done by voters).

Period

1 of 5

Remaining time [sec]: 171

There is a $\frac{1}{3}$ chance that Candidate 1's preferred policy is **A**, a $\frac{1}{3}$ chance that his/her preferred policy is **B**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.
There is a $\frac{1}{3}$ chance that Candidate 2's preferred policy is **E**, a $\frac{1}{3}$ chance that his/her preferred policy is **D**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

How would you like to answer these questions?

☐ Use sliders

☒ Enter numbers

If Candidate 1's preferred policy is **A**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy	Probability (%)
A	<input type="text"/>
B	<input type="text"/>
C	<input type="text"/>
no position	<input type="text" value="100"/>

If Candidate 2's preferred policy is **E**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy	Probability (%)
E	<input type="text"/>
D	<input type="text"/>
C	<input type="text"/>
no position	<input type="text" value="100"/>

OK

Screen for the second belief task (done by voters). This shows the slider option.

Period

1 of 5

Remaining time [sec]: 131

There is a $\frac{1}{3}$ chance that Candidate 1's preferred policy is **A**, a $\frac{1}{3}$ chance that his/her preferred policy is **B**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.
There is a $\frac{1}{3}$ chance that Candidate 2's preferred policy is **E**, a $\frac{1}{3}$ chance that his/her preferred policy is **D**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

How would you like to answer these questions?

☒ Use sliders

☐ Enter numbers

If Candidate 1 *does not take a position*, how likely do you think it is that his/her preferred policy is...

Policy	Probability (%)
A	Not possible <input type="range" value="75"/> Definitely 75
B	Not possible <input type="range" value="12"/> Definitely 12
C	Not possible <input type="range" value="12"/> Definitely 12

If Candidate 2 *does not take a position*, how likely do you think it is that his/her preferred policy is...

Policy	Probability (%)
E	Not possible <input type="range" value="75"/> Definitely 75
D	Not possible <input type="range" value="12"/> Definitely 12
C	Not possible <input type="range" value="12"/> Definitely 12

OK

Experiment Screenshots

Voting screen:


Period

1 of 5

Remaining time [sec]: 147

There is a $\frac{1}{3}$ chance that Candidate 1's preferred policy is **A**, a $\frac{1}{3}$ chance that his/her preferred policy is **B**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.
There is a $\frac{1}{3}$ chance that Candidate 2's preferred policy is **E**, a $\frac{1}{3}$ chance that his/her preferred policy is **D**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Candidate 1	Candidate 2	Vote	Candidate 1	Candidate 2	Vote
C	D	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	C	no position	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain
no position	D	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain	C	C	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain
B	D	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain	A	D	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain
A	C	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain	no position	C	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain
A	no position	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain	A	E	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain
B	no position	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	B	C	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain
C	E	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	B	E	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain
no position	E	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	no position	no position	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain



OK

Results screen, which is the last screen for each period.

Period

1 of 5

Remaining time [sec]: 54

Candidate 1's platform: B

Candidate 2's platform: no position

Number of votes for Candidate 1: 3

Number of votes for Candidate 2: 0

Winner: Candidate 1

Policy implemented: B

Points earned this round: 4

Continue

Experiment Screenshots

Treatment with Programmed Candidates

First screen subjects see in each practice period:

Period

Practice1 of 5

Remaining time [sec]: 35

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.

There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Please click the button to begin.

OK

This is the second screen subjects see in each practice period:

Period

Practice1 of 5

Remaining time [sec]: 76


There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.

There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Candidate 1	Candidate 2	Vote
no position	no position	<input type="radio"/> Candidate 1
		<input type="radio"/> Candidate 2
		<input checked="" type="radio"/> <u>abstain</u>



OK

Experiment Screenshots

This is the third and last screen in each practice period:

Period

Practice 1 of 5

Remaining time [sec]: 53

Candidate 1's platform: no position

Candidate 2's platform: no position

Number of votes for Candidate 1: 1

Number of votes for Candidate 2: 1

Winner: Candidate 2

Policy implemented: E

Points earned this round: 2

Continue

After 5 practice rounds, there is a screen for practicing answering belief questions. Here is what it looks like if the subject chooses to use the sliders:

Remaining time [sec]: 116

How would you like to answer these questions?

☒ Use sliders

☐ Enter numbers

When two coins are flipped independently, the probability of getting two heads is 1/4, the probability of getting two tails is 1/4, and the probability of getting one head and one tail is 1/2. Please show this either by using the sliders or by entering numbers.

All three outcomes are equally likely. Please show this either by using the sliders or by entering numbers.

Outcome		Probability (%)	Outcome		Probability (%)
Two heads	Not possible Definitely	25	X	Not possible Definitely	33
Two tails	Not possible Definitely	25	Y	Not possible Definitely	34
One head and one tail	Not possible Definitely	50	Z	Not possible Definitely	33

OK

Experiment Screenshots

Here is that same screen if he/she chooses to enter probabilities directly:


Remaining time [sec]: 76

How would you like to answer these questions? ☐ Use sliders ☒ Enter numbers

When two coins are flipped independently, the probability of getting two heads is $1/4$, the probability of getting two tails is $1/4$, and the probability of getting one head and one tail is $1/2$. Please show this either by using the sliders or by entering numbers.

All three outcomes are equally likely. Please show this either by using the sliders or by entering numbers.

Outcome	Probability (%)	Outcome	Probability (%)
Two heads	25	X	33
Two tails	25	Y	33
One head and one tail	50	Z	33



OK

Next, the actual election periods start. First screen in each period:

Period 1 of 5 Remaining time [sec]: 41

There is a $1/3$ chance that Candidate 1's preferred policy is **A**, a $1/3$ chance that his/her preferred policy is **B**, and a $1/3$ chance that his/her preferred policy is **C**.

There is a $1/3$ chance that Candidate 2's preferred policy is **E**, a $1/3$ chance that his/her preferred policy is **D**, and a $1/3$ chance that his/her preferred policy is **C**.

The preferred policy of all voters is **C**.

There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Please click the button to begin.

OK

Experiment Screenshots

Screen from the first belief task, with the slider option selected:

Period

1 of 5

Remaining time [sec]: 166

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

How would you like to answer these questions?

☒ Use sliders

☐ Enter numbers

If Candidate 1's preferred policy is **C**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy				Probability (%)
A	Not possible		Definitely	0
B	Not possible		Definitely	0
C	Not possible		Definitely	100
no position	Not possible		Definitely	0

If Candidate 2's preferred policy is **C**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy				Probability (%)
E	Not possible		Definitely	0
D	Not possible		Definitely	0
C	Not possible		Definitely	100
no position	Not possible		Definitely	0

OK

Another screen from the first belief task, with the “enter numbers” option selected.

Period

1 of 5

Remaining time [sec]: 167

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

How would you like to answer these questions?

☐ Use sliders

☒ Enter numbers

If Candidate 1's preferred policy is **B**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy	Probability (%)
A	<input type="text"/>
B	<input type="text" value="100"/>
C	<input type="text"/>
no position	<input type="text"/>

If Candidate 2's preferred policy is **D**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy	Probability (%)
E	<input type="text"/>
D	<input type="text" value="100"/>
C	<input type="text"/>
no position	<input type="text"/>

OK

Experiment Screenshots

Third and final screen for the first belief task:

Period 1 of 5 Remaining time [sec]: 171

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."


How would you like to answer these questions? ☐ Use sliders ☒ Enter numbers

If Candidate 1's preferred policy is **A**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy	Probability (%)
A	<input type="text"/>
B	<input type="text"/>
C	<input type="text"/>
no position	<input type="text" value="100"/>

If Candidate 2's preferred policy is **E**, how likely do you think it is that he/she will choose each of the following *campaign strategies*?

Policy	Probability (%)
E	<input type="text"/>
D	<input type="text"/>
C	<input type="text"/>
no position	<input type="text" value="100"/>

 OK

Screen for the second belief task. This shows the slider option.

Period 1 of 5 Remaining time [sec]: 131

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."


How would you like to answer these questions? ☒ Use sliders ☐ Enter numbers

If Candidate 1 *does not take a position*, how likely do you think it is that his/her preferred policy is...

Policy	Probability (%)
A	Not possible <input type="range" value="75"/> Definitely 75
B	Not possible <input type="range" value="12"/> Definitely 12
C	Not possible <input type="range" value="12"/> Definitely 12

If Candidate 2 *does not take a position*, how likely do you think it is that his/her preferred policy is...

Policy	Probability (%)
E	Not possible <input type="range" value="75"/> Definitely 75
D	Not possible <input type="range" value="12"/> Definitely 12
C	Not possible <input type="range" value="12"/> Definitely 12

 OK

Experiment Screenshots

Voting screen:


Period

1 of 5

Remaining time [sec]: 147

There is a **1/3** chance that Candidate 1's preferred policy is **A**, a **1/3** chance that his/her preferred policy is **B**, and a **1/3** chance that his/her preferred policy is **C**.
There is a **1/3** chance that Candidate 2's preferred policy is **E**, a **1/3** chance that his/her preferred policy is **D**, and a **1/3** chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."

Candidate 1	Candidate 2	Vote	Candidate 1	Candidate 2	Vote
C	D	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	C	no position	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain
no position	D	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain	C	C	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain
B	D	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain	A	D	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain
A	C	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain	no position	C	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain
A	no position	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain	A	E	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain
B	no position	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	B	C	<input type="radio"/> Candidate 1 <input checked="" type="radio"/> Candidate 2 <input type="radio"/> abstain
C	E	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	B	E	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain
no position	E	<input checked="" type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input type="radio"/> abstain	no position	no position	<input type="radio"/> Candidate 1 <input type="radio"/> Candidate 2 <input checked="" type="radio"/> abstain



OK

Results screen, which is the last screen for each period.

Period

1 of 5

Remaining time [sec]: 54

Candidate 1's platform: B
Candidate 2's platform: no position
Number of votes for Candidate 1: 3
Number of votes for Candidate 2: 0
Winner: Candidate 1
Policy implemented: B
Points earned this round: 4

Continue

Experiment Screenshots

Subjects complete 5 periods in each condition. Next, in the treatment with no beliefs only, there is a screen for practicing answering belief questions, shown after the instructions for that task are given. Here is what it looks like if the subject chooses to use the sliders:

Remaining time [sec]: 116

How would you like to answer these questions? ☒ Use sliders ☐ Enter numbers

When two coins are flipped independently, the probability of getting two heads is $1/4$, the probability of getting two tails is $1/4$, and the probability of getting one head and one tail is $1/2$. Please show this either by using the sliders or by entering numbers.

All three outcomes are equally likely. Please show this either by using the sliders or by entering numbers.

Outcome		Probability (%)	Outcome		Probability (%)
Two heads	Not possible Definitely	25	X	Not possible Definitely	33
Two tails	Not possible Definitely	25	Y	Not possible Definitely	34
One head and one tail	Not possible Definitely	50	Z	Not possible Definitely	33

OK

Same screen if he/she chooses to enter probabilities directly:

Remaining time [sec]: 76

How would you like to answer these questions? ☐ Use sliders ☒ Enter numbers

When two coins are flipped independently, the probability of getting two heads is $1/4$, the probability of getting two tails is $1/4$, and the probability of getting one head and one tail is $1/2$. Please show this either by using the sliders or by entering numbers.

All three outcomes are equally likely. Please show this either by using the sliders or by entering numbers.

Outcome	Probability (%)	Outcome	Probability (%)
Two heads	<input type="text" value="25"/>	X	<input type="text" value="33"/>
Two tails	<input type="text" value="25"/>	Y	<input type="text" value="33"/>
One head and one tail	<input type="text" value="50"/>	Z	<input type="text" value="33"/>

OK

Experiment Screenshots

This is an example of a question (there are 6 like it) from the task that tests how well people understand how to use probabilities, with the slider option selected.

Remaining time [sec]: 156




There is a $\frac{1}{3}$ chance that Candidate 1's preferred policy is **A**, a $\frac{1}{3}$ chance that his/her preferred policy is **B**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.
There is a $\frac{1}{3}$ chance that Candidate 2's preferred policy is **E**, a $\frac{1}{3}$ chance that his/her preferred policy is **D**, and a $\frac{1}{3}$ chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **25%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."


How would you like to answer these questions? ☒ Use sliders
☐ Enter numbers

The table below tells you what campaign strategy Candidate 1 will choose, depending on what his/her preferred policy is.

Candidate 1's Preferred Policy	Candidate 1's Chosen Strategy
A	no position
B	B
C	C

If Candidate 1 *does not take a position*, how likely do you think it is that his/her preferred policy is...

Policy	Probability (%)
A	Not possible  Definitely 64
B	Not possible  Definitely 18
C	Not possible  Definitely 18



OK

This is another question from this task, with the “enter numbers” option selected.

Remaining time [sec]: 150

There is a $\frac{1}{2}$ chance that Candidate 1's preferred policy is **A**, a $\frac{1}{4}$ chance that his/her preferred policy is **B**, and a $\frac{1}{4}$ chance that his/her preferred policy is **C**.
There is a $\frac{1}{2}$ chance that Candidate 2's preferred policy is **E**, a $\frac{1}{4}$ chance that his/her preferred policy is **D**, and a $\frac{1}{4}$ chance that his/her preferred policy is **C**.
The preferred policy of all voters is **C**.
There is a **10%** chance that the computer will not allow a candidate to commit, and his/her platform will be "no position."


How would you like to answer these questions? ☐ Use sliders
☒ Enter numbers

The table below tells you what campaign strategy Candidate 1 will choose, depending on what his/her preferred policy is.

Candidate 1's Preferred Policy	Candidate 1's Chosen Strategy
A	no position
B	B
C	C

If Candidate 1 *does not take a position*, how likely do you think it is that his/her preferred policy is...

Policy	Probability (%)
A	<input type="text" value="90"/>
B	<input type="text" value="5"/>
C	<input type="text" value="5"/>



OK

Experiment Screenshots

These are the on-screen instructions for the task that measures risk aversion using binary choices:

Remaining time [sec]: 51

On the next screen, you will face 6 decisions. For each one, you will be asked to choose between receiving 4 points for sure or playing a lottery that gives you a chance of winning 2 points, 4 points, or 10 points.


You will make 10 decisions in this section (6 on this screen and 4 on the other screen). One of these 10 choices will be randomly selected and you will be paid in dollars based on the number of points you earned from that decision.

If you have any questions, please raise your hand.

Please click the button to begin.

OK

This is that task:

Remaining time [sec]: 286	
<p>The lottery has a $\frac{5}{12}$ chance of paying 2 points, a $\frac{1}{3}$ chance of paying 4 points, and a $\frac{1}{4}$ chance of paying 10 points.</p> <p><input checked="" type="radio"/> choose the lottery <input type="radio"/> choose 4 points</p>	<p>The lottery has a $\frac{1}{2}$ chance of paying 2 points, a $\frac{1}{3}$ chance of paying 4 points, and a $\frac{1}{6}$ chance of paying 10 points.</p> <p><input checked="" type="radio"/> choose the lottery <input type="radio"/> choose 4 points</p>
<p>The lottery has a $\frac{2}{3}$ chance of paying 2 points, a $\frac{1}{6}$ chance of paying 4 points, and a $\frac{1}{6}$ chance of paying 10 points.</p> <p><input type="radio"/> choose the lottery <input checked="" type="radio"/> choose 4 points</p>	<p>The lottery has a $\frac{5}{6}$ chance of paying 2 points, a $\frac{1}{12}$ chance of paying 4 points, and a $\frac{1}{12}$ chance of paying 10 points.</p> <p><input type="radio"/> choose the lottery <input checked="" type="radio"/> choose 4 points</p>
<p>The lottery has a $\frac{1}{2}$ chance of paying 2 points, a $\frac{1}{4}$ chance of paying 4 points, and a $\frac{1}{4}$ chance of paying 10 points.</p> <p><input checked="" type="radio"/> choose the lottery <input type="radio"/> choose 4 points</p>	<p>The lottery has a $\frac{1}{3}$ chance of paying 2 points, a $\frac{1}{3}$ chance of paying 4 points, and a $\frac{1}{3}$ chance of paying 10 points.</p> <p><input checked="" type="radio"/> choose the lottery <input type="radio"/> choose 4 points</p>
<div></div> <div>OK</div>	

Experiment Screenshots

On-screen instructions for the task that measures risk aversion using a BDM mechanism:

Remaining time [sec]: 119

On the next screen, you will be asked to make 4 decisions. For each one, you will be told that you have a choice between receiving some number of points for sure and playing a lottery that pays some higher number of points if you win and nothing if you lose. You must determine how high the chance of winning must be in order for you to choose the lottery instead of taking the smaller number of points for sure.

For example, if you would take the lottery no matter what (even if there was no chance of winning), you would enter 0. If you would never play the lottery, you would enter 100, which means that you would only play the lottery if you would win for sure. If you would play the lottery as long as you had a 50% or higher chance of winning, you would enter 50.

For each decision, the computer will draw a number between 0 and 100 randomly; each number is equally likely to be chosen. This number is your chance of winning the lottery for this decision. If this number is at least as high as the probability you entered, you will play the lottery. If the number is lower than the number you entered, then you will receive the certain number of points.

For example, suppose you entered 50. If the computer draws 75, you will play a lottery that gives you a 75% chance of winning. If the computer draws 25, you will receive the certain number of points instead of playing the lottery that gives you a 25% chance of winning.

You will make 10 decisions in this section (4 on this screen and 6 on the other screen). One of these 10 choices will be randomly selected and you will be paid in dollars based on the number of points you earned from that decision.

If you have any questions, please raise your hand.


Please click the button to begin.

OK

BDM Task

Remaining time [sec]: 239

<p>You have a choice of receiving 4 points for sure or playing a lottery that pays 9 points if you win and pays nothing if you lose. Please fill in the blank with a number between 0 and 100.</p> <p>I choose to play the lottery if my percent chance of winning is at least <input type="text" value="71"/></p> <p>If my chance of winning is lower than that, I will take the 4 points instead.</p>	<p>You have a choice of receiving 5 points for sure or playing a lottery that pays 11 points if you win and pays nothing if you lose. Please fill in the blank with a number between 0 and 100.</p> <p>I choose to play the lottery if my percent chance of winning is at least <input type="text" value="44"/></p> <p>If my chance of winning is lower than that, I will take the 5 points instead.</p>
<p>You have a choice of receiving 4 points for sure or playing a lottery that pays 6 points if you win and pays nothing if you lose. Please fill in the blank with a number between 0 and 100.</p> <p>I choose to play the lottery if my percent chance of winning is at least <input type="text" value="87"/></p> <p>If my chance of winning is lower than that, I will take the 4 points instead.</p>	<p>You have a choice of receiving 5 points for sure or playing a lottery that pays 8 points if you win and pays nothing if you lose. Please fill in the blank with a number between 0 and 100.</p> <p>I choose to play the lottery if my percent chance of winning is at least <input type="text" value="81"/></p> <p>If my chance of winning is lower than that, I will take the 5 points instead.</p>



OK

Experiment Screenshots

BDM Task Results

Remaining time [sec]: 53	
<p>You had a choice of receiving 4 points for sure or playing a lottery that pays 9 points if you win and pays nothing if you lose.</p> <p>You chose to play the lottery if the percent chance of winning is at least 71</p> <p>The computer determined that your percent chance of winning for this lottery is 63</p> <p>You took the 4 points for sure.</p>	<p>You had a choice of receiving 5 points for sure or playing a lottery that pays 11 points if you win and pays nothing if you lose.</p> <p>You chose to play the lottery if the percent chance of winning is at least 44</p> <p>The computer determined that your percent chance of winning for this lottery is 4</p> <p>You took the 5 points for sure.</p>
<p>You had a choice of receiving 4 points for sure or playing a lottery that pays 6 points if you win and pays nothing if you lose.</p> <p>You chose to play the lottery if the percent chance of winning is at least 87</p> <p>The computer determined that your percent chance of winning for this lottery is 11</p> <p>You took the 4 points for sure.</p>	<p>You had a choice of receiving 5 points for sure or playing a lottery that pays 8 points if you win and pays nothing if you lose.</p> <p>You chose to play the lottery if the percent chance of winning is at least 81</p> <p>The computer determined that your percent chance of winning for this lottery is 19</p> <p>You took the 5 points for sure.</p>
<div>Continue</div>	

Binary Choice Task Results

Remaining time [sec]: 54	
<p>The lottery had a $\frac{5}{12}$ chance of paying 2 points, a $\frac{1}{3}$ chance of paying 4 points, and a $\frac{1}{4}$ chance of paying 10 points.</p> <p>You chose the lottery.</p> <p>You won 4 points.</p>	<p>The lottery had a $\frac{1}{2}$ chance of paying 2 points, a $\frac{1}{3}$ chance of paying 4 points, and a $\frac{1}{6}$ chance of paying 10 points.</p> <p>You chose the lottery.</p> <p>You won 10 points.</p>
<p>The lottery had a $\frac{2}{3}$ chance of paying 2 points, a $\frac{1}{6}$ chance of paying 4 points, and a $\frac{1}{6}$ chance of paying 10 points.</p> <p>You chose 4 points.</p>	<p>The lottery had a $\frac{5}{6}$ chance of paying 2 points, a $\frac{1}{12}$ chance of paying 4 points, and a $\frac{1}{12}$ chance of paying 10 points.</p> <p>You chose 4 points.</p> <p>This choice was randomly selected for payment.</p>
<p>The lottery had a $\frac{1}{2}$ chance of paying 2 points, a $\frac{1}{4}$ chance of paying 4 points, and a $\frac{1}{4}$ chance of paying 10 points.</p> <p>You chose the lottery.</p> <p>You won 4 points.</p>	<p>The lottery had a $\frac{1}{3}$ chance of paying 2 points, a $\frac{1}{3}$ chance of paying 4 points, and a $\frac{1}{3}$ chance of paying 10 points.</p> <p>You chose the lottery.</p> <p>You won 2 points.</p>
<div>Continue</div>	

Experiment Screenshots

This screen summarizes earnings at the end in the treatment with no beliefs:

Remaining time [sec]: 46

Round 1 in the set of rounds in which all preferred policies of candidates were equally likely and the probability that the computer would not allow a candidate to make a commitment was 10% has been chosen for payment. You earned \$10 in that round.

You earned \$2.00 based on the questions about your beliefs when you were told Candidate 1's strategy.

You earned \$5 from the section with choices involving lotteries.

In total, you earned \$17.00 during this experiment. This will be rounded up to the nearest dime, and you will receive this amount in addition to your show-up fee of \$5 and/or extra credit.

Continue

This screen summarizes earnings at the end in the treatments with beliefs:

Remaining time [sec]: 44

Round 1 in the set of rounds in which the probability that the computer would not allow a candidate to commit was 25% has been chosen for payment. You earned \$10 in that round.

Based on the questions about your beliefs during the election, you earned \$2.25.

You earned \$2.00 based on the questions about your beliefs when you were told Candidate 1's strategy.

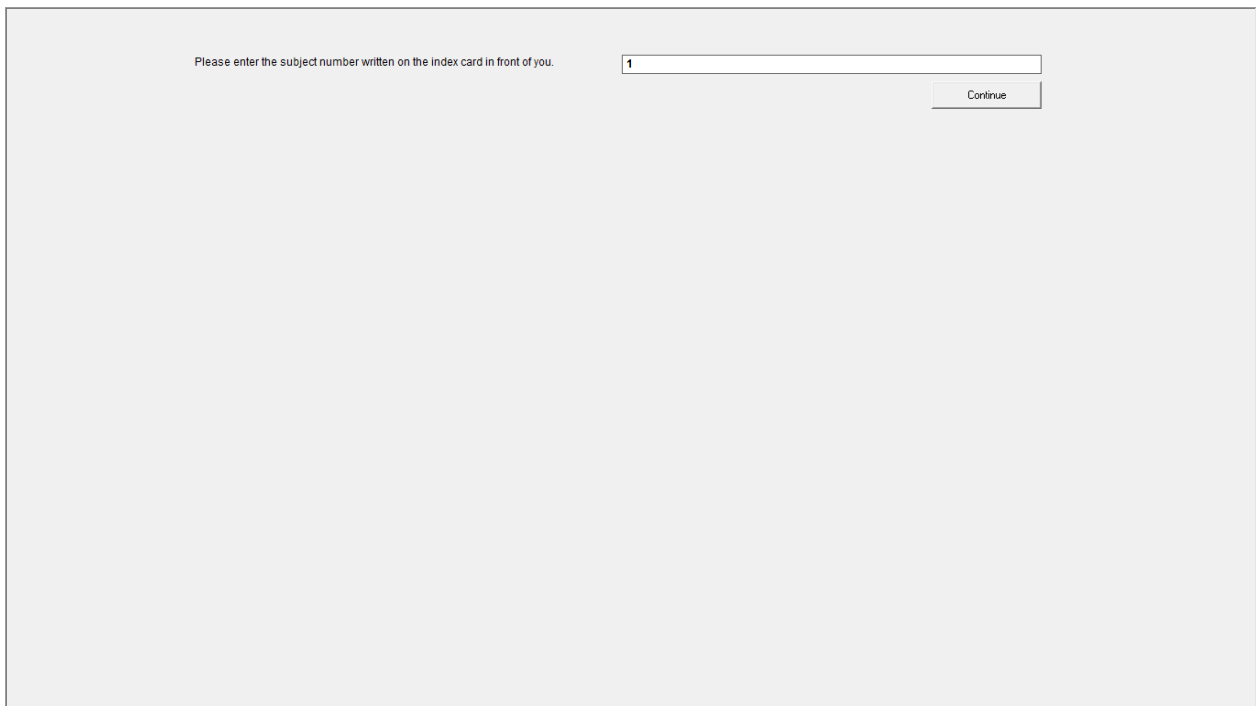
You earned \$5 from the section with choices involving lotteries.

In total, you earned \$19.25 during this experiment. This will be rounded up to the nearest dime, and you will receive this amount in addition to your show-up fee of \$5 and/or extra credit.

Continue

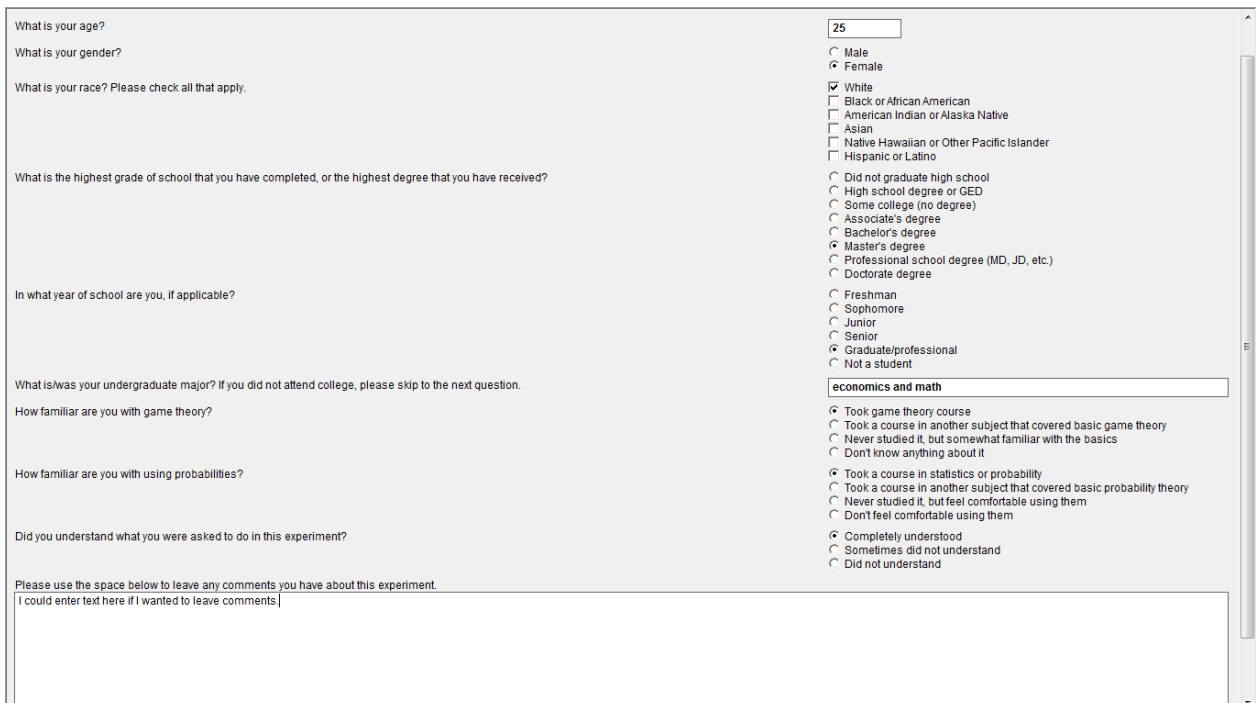
Experiment Screenshots

On this screen, subjects enter the number that identifies them in the experiment.



A screenshot of a web-based experiment interface. At the top, it says "Please enter the subject number written on the index card in front of you." Below this is a text input field containing the number "1". To the right of the input field is a button labeled "Continue". The background is a light gray.

This is the questionnaire:



A screenshot of a web-based questionnaire interface. The questions are listed on the left, and the answers are shown on the right. The questions are:

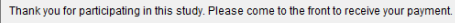
- What is your age? (Answer: 25)
- What is your gender? (Answer: Female)
- What is your race? Please check all that apply. (Answer: White)
- What is the highest grade of school that you have completed, or the highest degree that you have received? (Answer: Master's degree)
- In what year of school are you, if applicable? (Answer: Graduate/professional)
- What is/was your undergraduate major? If you did not attend college, please skip to the next question. (Answer: economics and math)
- How familiar are you with game theory? (Answer: Took game theory course)
- How familiar are you with using probabilities? (Answer: Took a course in statistics or probability)
- Did you understand what you were asked to do in this experiment? (Answer: Completely understood)

At the bottom, there is a text area for comments: "Please use the space below to leave any comments you have about this experiment. I could enter text here if I wanted to leave comments."

Experiment Screenshots

The screen cut off a bit, but it's just the rest of the comment box and a button that subjects click to continue.

This is the last screen the subjects see:

A screenshot of a computer screen with a light gray background. The text "Thank you for participating in this study. Please come to the front to receive your payment." is displayed in the top left corner in a small, black, sans-serif font. The rest of the screen is empty.

Thank you for participating in this study. Please come to the front to receive your payment.

B.2 Belief Incentivization Procedure

The belief report incentivization procedure is based on that developed by McKelvey and Page (1990). If a subject is asked for her beliefs about the preferred position of a candidate who takes no position and that candidate actually takes no position, the subject takes part in a lottery. Consider the case for Candidate 1; the procedure is the same if Candidate 2 takes no position. Let p_j be equal to 1 if the candidate's preferred policy is j and 0 otherwise. Let r_j be the subject's reported probability that the candidate's preferred policy is j . Her probability of winning the lottery is $1 - \frac{1}{2}(p_A - r_A)^2 - \frac{1}{2}(p_B - r_B)^2 - \frac{1}{2}(p_C - r_C)^2$. Given beliefs $\tilde{\pi}$, a subject chooses her report to maximize

$$\begin{aligned} & \left[1 - \frac{1}{2}(\tilde{\pi}_A - r_A)^2 - \frac{1}{2}(\tilde{\pi}_B - r_B)^2 - \frac{1}{2}(\tilde{\pi}_C - r_C)^2 \right] u(\text{win}) \\ & + \left[\frac{1}{2}(\tilde{\pi}_A - r_A)^2 + \frac{1}{2}(\tilde{\pi}_B - r_B)^2 + \frac{1}{2}(\tilde{\pi}_C - r_C)^2 \right] u(\text{loss}) = \\ & u(\text{win}) - \frac{1}{2}(\tilde{\pi}_A - r_A)^2 [u(\text{win}) - u(\text{loss})] \\ & - \frac{1}{2}(\tilde{\pi}_B - r_B)^2 [u(\text{win}) - u(\text{loss})] - \frac{1}{2}(\tilde{\pi}_C - r_C)^2 [u(\text{win}) - u(\text{loss})] \end{aligned}$$

The subject maximizes her expected payoff by reporting truthfully as long as she prefers winning the lottery to losing it; no risk neutrality assumption is needed. In order to ensure that simply entering more lotteries (because candidates took no position more often) doesn't increase payoffs, subjects are paid the proportion of the lotteries that they win multiplied by \$3.

A similar procedure is used to incentivize responses in the Bayes' rule task. Each subject is entered into a lottery for each of the six questions. Her probability of winning each lottery is the same as in the procedure above; thus, the same result of truth-telling being incentive-compatible goes through. However, for this task, p_j is the true probability that a candidate who took no position has preferred policy j , calculated using the values for π and γ and the strategies for candidates given to the subjects in the question. Subjects are paid the percentage

of these lotteries that they win multiplied by \$2.

B.3 Equilibria in Mixed Strategies

Because this analysis accompanies the experiment, it uses the notion introduced in that chapter of having monetary payoffs associated with outcomes and having preferences over those monetary payoffs. Let x_{i+1} be the monetary payoff associated with distance i between preferred policy and implemented policy, for $i = 0, 1, 2, 3, 4$. This is analogous to the notation used in the theory chapter; x_1 is the monetary payoff associated with the most preferred policy, x_2 is the monetary payoff associated with the second-best policy, and so on. In the numerical calculations done in this section, the monetary payoffs from the experiment are used: $x_1 = 10, x_2 = 4, x_3 = 2, x_4 = 1, x_5 = 0$.

Let q_{ij} be the probability that a candidate of type i chooses strategy j . Consider only symmetric equilibria. This implies that notation can be simplified, using the notation that corresponds to the strategies and types of Candidate 1.

Lemma 3. *Suppose that there exists an equilibrium in mixed strategies in which voters support a candidate who takes no position over a candidate who commits to B/D. Then, candidates who prefer B/D will not put positive probability on committing to B/D.*

Proof. Suppose to the contrary that $q_{BB} \in (0, 1]$. Then, the payoff for a candidate who prefers B/D when he commits to B/D is greater than or equal to the payoff when he takes no position. The payoff when he commits to B/D is

$$\begin{aligned} & \pi_A q_{AC} [\gamma^2 u_c(x_2) + \gamma(1-\gamma)u_c(x_4) + \gamma(1-\gamma)u_c(x_2)] \\ & + \pi_A q_{AB} \left[\gamma^2 \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_3) \right) + \gamma(1-\gamma)u_c(x_4) + \gamma(1-\gamma)u_c(x_1) \right] \\ & + \pi_A q_{An} [\gamma u_c(x_4)] + \pi_A (1-\gamma) \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_4) \right) [q_{AC}(1-\gamma) + q_{AB}(1-\gamma) + q_{An}] \\ & + \pi_B q_{BC} [\gamma^2 u_c(x_2) + \gamma(1-\gamma)u_c(x_3) + \gamma(1-\gamma)u_c(x_2)] \end{aligned}$$

$$\begin{aligned}
& +\pi_B q_{BB} \left[\gamma^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) + \gamma(1-\gamma) u_c(x_3) + \gamma(1-\gamma) u_c(x_1) \right] \\
& +\pi_B q_{Bn} [\gamma u_c(x_3)] + \pi_B (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) [q_{BC}(1-\gamma) + q_{BB}(1-\gamma) + q_{Bn}] \\
& +\pi_C \left[\gamma^2 u_c(x_2) + \gamma(1-\gamma) u_c(x_2) + \gamma(1-\gamma) u_c(x_2) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]
\end{aligned}$$

The payoff when he takes no position is

$$\begin{aligned}
& \pi_A \gamma [q_{AC} u_c(x_2) + q_{AB} u_c(x_1)] \\
& +\pi_A (q_{AC}(1-\gamma) + q_{AB}(1-\gamma) + q_{An}) \left[\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right] \\
& +\pi_B \gamma [q_{BC} u_c(x_2) + q_{BB} u_c(x_1)] \\
& +\pi_B (q_{BC}(1-\gamma) + q_{BB}(1-\gamma) + q_{Bn}) \left[\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right] \\
& +\pi_C \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]
\end{aligned}$$

Then it must be the case that

$$\begin{aligned}
& q_{AC} \pi_A \gamma [u_c(x_1) - u_c(x_4)] - \pi_A [u_c(x_1) - u_c(x_4)] + q_{AB} \gamma \pi_A [u_c(x_3) - u_c(x_4)] \\
& (\gamma q_{BC} - 1) \pi_B [u_c(x_1) - u_c(x_3)] + (1-\gamma) \pi_C [u_c(x_2) - u_c(x_1)] \geq 0
\end{aligned}$$

To show that this inequality cannot hold regardless of what strategy is chosen by candidates who prefer A/E, choose values for the q 's to make the left hand side as high as positive. This means making $q_{AC} = 1$ and $q_{BC} = 1$. Since the LHS is still negative with these values, and it would be even smaller with any other set of values, this condition must not hold. Therefore, this is a contradiction, and candidates who prefer B/D cannot choose to commit to B/D with positive probability. \square

Lemma 4. *If there exists a mixed strategy equilibrium in which voters prefer a candidate who takes no position over a candidate who commits to B/D, then candidates who prefer A/E do not put positive probability on committing to B/D.*

Proof. Suppose to the contrary that $q_{AB} \in (0, 1]$. The payoff of a candidate who prefers A/E from committing to B/D is:

$$\begin{aligned}
& \pi_A q_{AC} \left[\gamma^2 u_c(x_3) + \gamma(1-\gamma) u_c(x_5) + \gamma(1-\gamma) u_c(x_3) \right] \\
& + \pi_A q_{AB} \left[\gamma^2 \left(\frac{1}{2} u(x_2) + \frac{1}{2} u(x_4) \right) + \gamma(1-\gamma) u(x_5) + \gamma(1-\gamma) u(x_1) \right] \\
& + \pi_A q_{An} \gamma u(x_5) + \pi_A (1-\gamma) \left(\frac{1}{2} u(x_1) + \frac{1}{2} u(x_5) \right) (q_{AC}(1-\gamma) + q_{AB}(1-\gamma) + q_{An}) \\
& + \pi_B q_{BC} \left[\gamma^2 u(x_3) + \gamma(1-\gamma) u(x_4) + \gamma(1-\gamma) u(x_3) \right] \\
& + \pi_B q_{BB} \left[\gamma^2 \left(\frac{1}{2} u(x_2) + \frac{1}{2} u(x_4) \right) + \gamma(1-\gamma) u(x_4) + \gamma(1-\gamma) u(x_1) \right] \\
& + \pi_B q_{Bn} [\gamma u(x_4)] + \pi_B (1-\gamma) \left(\frac{1}{2} u(x_1) + \frac{1}{2} u(x_4) \right) (q_{BC}(1-\gamma) + q_{BB}(1-\gamma) + q_{Bn}) \\
& + \pi_C \left[\gamma^2 u(x_3) + \gamma(1-\gamma) u(x_3) + \gamma(1-\gamma) u(x_3) + (1-\gamma)^2 \left(\frac{1}{2} u(x_1) + \frac{1}{2} u(x_3) \right) \right]
\end{aligned}$$

His payoff from taking no position is:

$$\begin{aligned}
& + \pi_A (q_{AC}(1-\gamma) + q_{AB}(1-\gamma) + q_{An}) \left(\frac{1}{2} u(x_1) + \frac{1}{2} u(x_5) \right) \\
& + \pi_A \gamma [q_{AC} u(x_3) + q_{AB} u(x_1)] + \pi_B \gamma [q_{BC} u(x_3) + q_{BB} u(x_1)] \\
& + \pi_B (q_{BC}(1-\gamma) + q_{BB}(1-\gamma) + q_{Bn}) \left(\frac{1}{2} u(x_1) + \frac{1}{2} u(x_4) \right) \\
& + \pi_C \left[\gamma u(x_3) + (1-\gamma) \left(\frac{1}{2} u(x_1) + \frac{1}{2} u(x_3) \right) \right]
\end{aligned}$$

Then, his payoff from committing to B/D must be at least as high as his payoff from taking no position:

$$\begin{aligned}
& + \pi_A q_{AB} [\gamma(u(x_2) + u(x_4)) - (1+\gamma)u(x_1)] \\
& - (1-\gamma) \pi_A q_{AC} u(x_1) - \pi_A q_{An} [u(x_1)] \\
& + (1-\gamma) \pi_B q_{BC} [u(x_4) - u(x_1)] \\
& + \pi_B q_{BB} [\gamma u(x_2) + u(x_4) - (1+\gamma)u(x_1)] \\
& + \pi_B q_{Bn} [u(x_4) - u(x_1)] + (1-\gamma) \pi_C [u(x_3) - u(x_1)] \geq 0
\end{aligned}$$

Using Lemma 3, substitute $q_{BB} = 0$:

$$\begin{aligned} & (\gamma q_{AC} - 1) \pi_A u(x_1) + \gamma \pi_A q_{AB} [u(x_2) + u(x_4) - u(x_1)] \\ & + (\gamma q_{BC} - 1) \pi_B [u(x_1) - u(x_4)] + (1 - \gamma) \pi_C [u(x_3) - u(x_1)] \geq 0 \end{aligned}$$

Choose values to make the left hand side as high as positive. This means $q_{BC} = 1$. Depending on α_c , either q_{AB} or q_{AC} should be 1. In either case, the left hand side is negative. Since these values were chosen to maximize the left hand side, this equation cannot hold for any values. Thus, there is a contradiction. \square

Proposition 15. *Suppose that*

$$(\pi_A, \pi_B, \pi_C, \gamma) = \left(\frac{1}{2}, \frac{1}{4}, \frac{1}{4}, \frac{9}{10} \right), \alpha_c < 0.18,$$

$$(\pi_A, \pi_B, \pi_C, \gamma) = \left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{9}{10} \right), \alpha_c < 0.19,$$

or

$$(\pi_A, \pi_B, \pi_C, \gamma) = \left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{3}{4} \right), \alpha_c < 0.23$$

Then, there does not exist an equilibrium in mixed strategies in which voters vote for the candidate who took no position over one who commits to B/D.

Proof. By Lemmas 3 and 4, we know that $q_{AB} = q_{BB} = 0$. The remaining possibilities are that one type of candidate commits to C or takes no position and the other mixes between those two strategies, or both mix. Consider each possibility in turn. Suppose that candidates who prefer B/D commit to C and candidates who prefer A/E mix. The payoff for a candidate who prefers A/E if he takes no position is

$$\begin{aligned} & \pi_A q_{AC} \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \right] + \pi_A q_{An} \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \\ & + \pi_B \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \end{aligned}$$

$$+\pi_C \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right]$$

Substituting $q_{An} = 1 - q_{AC}$, we have

$$\begin{aligned} & \pi_A q_{AC} \left[\gamma u_c(x_3) - \frac{1}{2} \gamma u_c(x_1) \right] + \pi_A \frac{1}{2} u_c(x_1) \\ & + \pi_B \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\ & + \pi_C \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \end{aligned}$$

The payoff for a candidate who prefers A/E if he commits to C is

$$\begin{aligned} & \pi_A q_{AC} \left[\gamma^2 u_c(x_3) + \gamma(1-\gamma) u_c(x_3) + \gamma(1-\gamma) u_c(x_3) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \right] \\ & \quad + \pi_A q_{An} \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \right] \\ & + \pi_B \left[\gamma^2 u_c(x_3) + \gamma(1-\gamma) u_c(x_3) + \gamma(1-\gamma) u_c(x_3) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\ & + \pi_C \left[\gamma^2 u_c(x_3) + \gamma(1-\gamma) u_c(x_3) + \gamma(1-\gamma) u_c(x_3) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \end{aligned}$$

Substituting $q_{An} = 1 - q_{AC}$, we have

$$\begin{aligned} & \pi_A q_{AC} \left[(\gamma - \gamma^2) u_c(x_3) - \gamma(1-\gamma) \left(\frac{1}{2} u_c(x_1) \right) \right] \\ & \quad + \pi_A \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) \right) \right] \\ & + \pi_B \left[(2\gamma - \gamma^2) u_c(x_3) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\ & + \pi_C \left[(2\gamma - \gamma^2) u_c(x_3) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \end{aligned}$$

Since the candidates who prefers A/E is mixing, he must be indifferent between

these two strategies:

$$\begin{aligned}
& \pi_A q_{AC} \left[(\gamma - \gamma^2) u_c(x_3) - \gamma(1 - \gamma) \left(\frac{1}{2} u_c(x_1) \right) \right] \\
& \quad + \pi_A \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) \right) \right] \\
& + \pi_B \left[(2\gamma - \gamma^2) u_c(x_3) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& + \pi_C \left[(2\gamma - \gamma^2) u_c(x_3) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] = \\
& \quad \pi_A q_{AC} \left[\gamma u_c(x_3) - \frac{1}{2} \gamma u_c(x_1) \right] + \pi_A \frac{1}{2} u_c(x_1) \\
& \quad + \pi_B \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& \quad + \pi_C \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right]
\end{aligned}$$

Simplified, this becomes

$$q_{AC} = \frac{1}{\gamma} + \frac{(1 - \gamma) \pi_B}{\gamma \pi_A} \frac{\left[\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) - u_c(x_3) \right]}{\left[\frac{1}{2} u_c(x_1) - u_c(x_3) \right]} + \frac{(1 - \gamma) \pi_C}{\gamma \pi_A} \frac{\left[\frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_3) \right]}{\left[\frac{1}{2} u_c(x_1) - u_c(x_3) \right]}$$

Numerical calculations show that $q_{AC} \in [0, 1]$ if and only if $\alpha_c \in [0.35, 0.486]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = \left(\frac{1}{2}, \frac{1}{4}, \frac{1}{4}, \frac{9}{10}\right)$, $\alpha_c \in [0.37, 0.579]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = \left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{9}{10}\right)$, and $\alpha_c \in [0.421, 0.579]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = \left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{3}{4}\right)$.

Next, suppose that candidates who prefer B/D take no position, and candidates who prefer A/E mix. If the candidate who prefers A/E commits to C, his payoff is

$$\begin{aligned}
& \pi_A q_{AC} \left[\gamma^2 u_c(x_3) + \gamma(1 - \gamma) u_c(x_3) + \gamma(1 - \gamma) u_c(x_3) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \right] \\
& \quad + \pi_A q_{An} \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \right] \\
& \quad + \pi_B \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right]
\end{aligned}$$

$$+\pi_C \left[\gamma^2 u_c(x_3) + \gamma(1-\gamma)u_c(x_3) + \gamma(1-\gamma)u_c(x_3) + (1-\gamma)^2 \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_3) \right) \right]$$

If we substitute $q_{An} = 1 - q_{AC}$, we have

$$\begin{aligned} & \pi_A q_{AC} \left[(\gamma - \gamma^2) u_c(x_3) - \gamma(1-\gamma) \left(\frac{1}{2}u_c(x_1) \right) \right] \\ & + \pi_A \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2}u_c(x_1) \right) \right] \\ & + \pi_B \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_4) \right) \right] \\ & + \pi_C \left[\gamma^2 u_c(x_3) + \gamma(1-\gamma)u_c(x_3) + \gamma(1-\gamma)u_c(x_3) + (1-\gamma)^2 \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_3) \right) \right] \end{aligned}$$

If the candidate who prefers A/E takes no position, his payoff is

$$\begin{aligned} & \pi_A q_{AC} \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_5) \right) \right] + \pi_A q_{An} \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_5) \right) \\ & + \pi_B \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_4) \right) \\ & + \pi_C \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_3) \right) \right] \end{aligned}$$

If we substitute $q_{An} = 1 - q_{AC}$, we have

$$\begin{aligned} & \pi_A q_{AC} \left[\gamma u_c(x_3) - \gamma \frac{1}{2}u_c(x_1) \right] + \pi_A \frac{1}{2}u_c(x_1) \\ & + \pi_B \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_4) \right) \\ & + \pi_C \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2}u_c(x_1) + \frac{1}{2}u_c(x_3) \right) \right] \end{aligned}$$

Since the candidate who prefers A/E mixes, he must be indifferent between choosing these two strategies:

$$\pi_A q_{AC} \left[(\gamma - \gamma^2) u_c(x_3) - \gamma(1-\gamma) \left(\frac{1}{2}u_c(x_1) \right) \right]$$

$$\begin{aligned}
& +\pi_A \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) \right) \right] \\
& +\pi_B \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& +\pi_C \left[(2\gamma - \gamma^2) u_c(x_3) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] = \\
& \pi_A q_{AC} \left[\gamma u_c(x_3) - \gamma \frac{1}{2} u_c(x_1) \right] + \pi_A \frac{1}{2} u_c(x_1) \\
& +\pi_B \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \\
& +\pi_C \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right]
\end{aligned}$$

This simplifies to

$$q_{AC} = \frac{1}{\gamma} + \frac{1}{\gamma} \frac{\pi_B \left[\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) - u_c(x_3) \right]}{\pi_A \left[\frac{1}{2} u_c(x_1) - u_c(x_3) \right]} + \frac{(1-\gamma) \pi_C \left[\frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_3) \right]}{\gamma \pi_A \left[\frac{1}{2} u_c(x_1) - u_c(x_3) \right]}$$

Numerical calculations show that $q_{AC} \in [0, 1]$ if and only if $\alpha_c \in [0.404, 0.601]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = (\frac{1}{2}, \frac{1}{4}, \frac{1}{4}, \frac{9}{10})$; $\alpha_c \in [0.453, 0.654]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = (\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{9}{10})$; and $\alpha_c \in [0.476, 0.624]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = (\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{3}{4})$.

Next, suppose that a candidate who prefers A/E commits to C and a candidate who prefers B/D mixes. The payoff for a candidate who prefers B/D if she takes no position is

$$\begin{aligned}
& \pi_A \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& +\pi_B q_{BC} \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] + \pi_B q_{Bn} \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \\
& +\pi_C \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]
\end{aligned}$$

Replacing $q_{An} = 1 - q_{AC}$ and $q_{Bn} = 1 - q_{BC}$, this becomes

$$\pi_A \left[\gamma u_c(x_2) - \frac{1}{2} \gamma u_c(x_1) - \frac{1}{2} \gamma u_c(x_4) \right] + \pi_A \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right)$$

$$\begin{aligned}
& +\pi_B q_{BC} \left[\gamma u_c(x_2) - \frac{1}{2} \gamma u_c(x_1) - \frac{1}{2} \gamma u_c(x_3) \right] + \pi_B \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \\
& + \pi_C \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]
\end{aligned}$$

The payoff for a candidate who prefers B/D if she commits to C is

$$\begin{aligned}
& \pi_A \left[(2\gamma - \gamma^2) u_c(x_2) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& + \pi_B q_{BC} \left[(2\gamma - \gamma^2) u_c(x_2) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\
& + \pi_B q_{Bn} \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\
& + \pi_C \left[(2\gamma - \gamma^2) u_c(x_2) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]
\end{aligned}$$

Replacing $q_{An} = 1 - q_{AC}$ and $q_{Bn} = 1 - q_{BC}$, this becomes

$$\begin{aligned}
& \pi_A \left[(\gamma - \gamma^2) u_c(x_2) - \gamma(1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& + \pi_A \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& + \pi_B q_{BC} \left[(\gamma - \gamma^2) u_c(x_2) - \gamma(1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\
& + \pi_B \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\
& + \pi_C \left[(2\gamma - \gamma^2) u_c(x_2) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]
\end{aligned}$$

The candidate who prefers B/D is indifferent between choosing these strategies if and only if

$$\begin{aligned}
& \pi_A \left[\gamma u_c(x_2) - \frac{1}{2} \gamma u_c(x_1) - \frac{1}{2} \gamma u_c(x_4) \right] + \pi_A \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \\
& + \pi_B q_{BC} \left[\gamma u_c(x_2) - \frac{1}{2} \gamma u_c(x_1) - \frac{1}{2} \gamma u_c(x_3) \right] + \pi_B \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \\
& + \pi_C \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right] =
\end{aligned}$$

$$\begin{aligned}
& \pi_A \left[(\gamma - \gamma^2) u_c(x_2) - \gamma(1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& + \pi_A \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& + \pi_B q_{BC} \left[(\gamma - \gamma^2) u_c(x_2) - \gamma(1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\
& + \pi_B \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\
& + \pi_C \left[(2\gamma - \gamma^2) u_c(x_2) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]
\end{aligned}$$

This reduces to

$$q_{BC} = \frac{1}{\gamma} \left[1 + (1 - \gamma) \frac{\pi_A \left[u_c(x_2) - \frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_4) \right] + \pi_C \left[\frac{1}{2} u_c(x_2) - \frac{1}{2} u_c(x_1) \right]}{\pi_B \left[u_c(x_2) - \frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_3) \right]} \right]$$

Numerical calculations show that $q_{BC} \in [0, 1]$ if and only if $\alpha_c \in [0.270, 0.292]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = (\frac{1}{2}, \frac{1}{4}, \frac{1}{4}, \frac{9}{10})$; $\alpha_c \in [0.311, 0.325]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = (\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{9}{10})$; and $\alpha_c \in [0.316, 0.325]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = (\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{3}{4})$.

Suppose that a candidate who prefers A/E takes no position and a candidate who prefers B/D mixes between committing to C and taking no position.

The payoff for a candidate who prefers B/D if she takes no position is

$$\begin{aligned}
& \pi_A \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \\
& + \pi_B q_{BC} \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] + \pi_B q_{Bn} \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \\
& + \pi_C \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]
\end{aligned}$$

Replacing $q_{Bn} = 1 - q_{BC}$, this becomes

$$\begin{aligned}
& \pi_A \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \\
& + \pi_B q_{BC} \left[\gamma u_c(x_2) - \frac{1}{2} \gamma u_c(x_1) - \frac{1}{2} \gamma u_c(x_3) \right] + \pi_B \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right)
\end{aligned}$$

$$+\pi_C \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]$$

The payoff for a candidate who prefers B/D if she commits to C is

$$\begin{aligned} & +\pi_A \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\ & +\pi_B q_{BC} \left[(2\gamma - \gamma^2) u_c(x_2) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\ & +\pi_B q_{Bn} \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\ & +\pi_C \left[(2\gamma - \gamma^2) u_c(x_2) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right] \end{aligned}$$

Replacing $q_{Bn} = 1 - q_{BC}$, this becomes

$$\begin{aligned} & +\pi_A \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\ & +\pi_B q_{BC} \left[(\gamma - \gamma^2) u_c(x_2) - \gamma(1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\ & +\pi_B \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\ & +\pi_C \left[(2\gamma - \gamma^2) u_c(x_2) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right] \end{aligned}$$

The candidate who prefers B/D is willing to mix if and only if

$$\begin{aligned} & \pi_A \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \\ & +\pi_B q_{BC} \left[\gamma u_c(x_2) - \frac{1}{2} \gamma u_c(x_1) - \frac{1}{2} \gamma u_c(x_3) \right] + \pi_B \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \\ & +\pi_C \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right] > \\ & +\pi_A \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\ & +\pi_B q_{BC} \left[(\gamma - \gamma^2) u_c(x_2) - \gamma(1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\ & +\pi_B \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \end{aligned}$$

$$+\pi_C \left[(2\gamma - \gamma^2) u_c(x_2) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]$$

This reduces to

$$q_{BC} = \frac{1}{\gamma} \left(1 + \frac{\pi_A \left[u_c(x_2) - \frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_4) \right] + (1 - \gamma) \pi_C \left[\frac{1}{2} u_c(x_2) - \frac{1}{2} u_c(x_1) \right]}{\pi_B \left[u_c(x_2) - \frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_3) \right]} \right)$$

By numerical calculation, $q_{BC} \in [0, 1]$ if and only if $\alpha_c \in [0.177, 0.203]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = (\frac{1}{2}, \frac{1}{4}, \frac{1}{4}, \frac{9}{10})$; $\alpha_c \in [0.191, 0.228]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = (\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{9}{10})$; and $\alpha_c \in [0.227, 0.247]$ if $(\pi_A, \pi_B, \pi_C, \gamma) = (\frac{1}{3}, \frac{1}{3}, \frac{1}{3}, \frac{3}{4})$.

Finally, suppose that both candidates are mixing. The payoff of a candidate who prefers A/E if he commits to C is

$$\begin{aligned} & \pi_A q_{AC} \left[\gamma^2 u_c(x_3) + \gamma(1 - \gamma) u_c(x_3) + \gamma(1 - \gamma) u_c(x_3) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \right] \\ & \quad + \pi_A q_{An} \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \right] \\ & + \pi_B q_{BC} \left[\gamma^2 u_c(x_3) + \gamma(1 - \gamma) u_c(x_3) + \gamma(1 - \gamma) u_c(x_3) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\ & \quad + \pi_B q_{Bn} \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\ & + \pi_C \left[\gamma^2 u_c(x_3) + \gamma(1 - \gamma) u_c(x_3) + \gamma(1 - \gamma) u_c(x_3) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \end{aligned}$$

If he takes no position, his payoff is

$$\begin{aligned} & \pi_A q_{AC} \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \right] + \pi_A q_{An} \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \\ & + \pi_B q_{BC} \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] + \pi_B q_{Bn} \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \\ & + \pi_C \left[\gamma u_c(x_3) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \end{aligned}$$

Since he must be indifferent, it must be the case that

$$\begin{aligned}
& \pi_A q_{AC} \left[\gamma^2 u_c(x_3) + \gamma(1-\gamma) u_c(x_3) + \gamma(1-\gamma) u_c(x_3) \right] \\
& + \pi_A q_{An} \gamma u_c(x_3) + \pi_A (1-\gamma) (q_{AC}(1-\gamma) + q_{An}) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \\
& + \pi_B q_{BC} \left[\gamma^2 u_c(x_3) + \gamma(1-\gamma) u_c(x_3) + \gamma(1-\gamma) u_c(x_3) \right] \\
& + \pi_B q_{Bn} \gamma u_c(x_3) + \pi_B (1-\gamma) (q_{BC}(1-\gamma) + q_{Bn}) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \\
& + \pi_C \left[(2\gamma - \gamma^2) u_c(x_3) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] = \\
& \pi_A q_{AC} \gamma u_c(x_3) + \pi_A (q_{AC}(1-\gamma) + q_{An}) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_5) \right) \\
& + \pi_B q_{BC} \gamma u_c(x_3) + \pi_B (q_{BC}(1-\gamma) + q_{Bn}) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \\
& + \pi_C \left[\gamma u_c(x_3) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right]
\end{aligned}$$

This reduces to

$$\begin{aligned}
& + (1 - \gamma q_{AC}) \pi_A \left[u_c(x_3) - \frac{1}{2} u_c(x_1) \right] \\
& + (1 - \gamma q_{BC}) \pi_B \left[u_c(x_3) - \frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_4) \right] \\
& + \frac{1}{2} (1 - \gamma) \pi_C [u_c(x_3) - u_c(x_1)] = 0
\end{aligned}$$

The payoff for a candidate who prefers B/D if he commits to C is

$$\begin{aligned}
& \pi_A q_{AC} \left[(2\gamma - \gamma^2) u_c(x_2) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& + \pi_A (1 - q_{AC}) \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\
& + \pi_B q_{BC} \left[(2\gamma - \gamma^2) u_c(x_2) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\
& + \pi_B (1 - q_{BC}) \left[\gamma u_c(x_2) + (1-\gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\
& + \pi_C \left[(2\gamma - \gamma^2) u_c(x_2) + (1-\gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right]
\end{aligned}$$

The payoff for this candidate if he takes no position is

$$\begin{aligned} & \pi_A q_{AC} \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] + \pi_A (1 - q_{AC}) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \\ & + \pi_B q_{BC} \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] + \pi_B (1 - q_{BC}) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \\ & + \pi_C \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right] \end{aligned}$$

Since he must be willing to mix, it must be the case that

$$\begin{aligned} & \pi_A q_{AC} \left[(2\gamma - \gamma^2) u_c(x_2) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\ & + \pi_A (1 - q_{AC}) \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \right] \\ & + \pi_B q_{BC} \left[(2\gamma - \gamma^2) u_c(x_2) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\ & + \pi_B (1 - q_{BC}) \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \right] \\ & + \pi_C \left[(2\gamma - \gamma^2) u_c(x_2) + (1 - \gamma)^2 \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right] = \\ & \pi_A q_{AC} \gamma u_c(x_2) + \pi_A (1 - \gamma q_{AC}) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) \right) \\ & + \pi_B q_{BC} [\gamma u_c(x_2)] + \pi_B (1 - \gamma q_{BC}) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) \right) \\ & + \pi_C \left[\gamma u_c(x_2) + (1 - \gamma) \left(\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_2) \right) \right] \end{aligned}$$

This reduces to

$$\begin{aligned} & + (1 - \gamma q_{AC}) \pi_A = \\ & + (1 - \gamma q_{BC}) \pi_B \frac{\left[\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) - u_c(x_2) \right]}{\left[u_c(x_2) - \frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_4) \right]} \\ & + \frac{1}{2} (1 - \gamma) \pi_C \frac{[u_c(x_1) - u_c(x_2)]}{\left[u_c(x_2) - \frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_4) \right]} \end{aligned}$$

From above, we have

$$\begin{aligned}
& + (1 - \gamma q_{AC}) \pi_A = \\
& + (1 - \gamma q_{BC}) \pi_B \frac{\left[\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) - u_c(x_3) \right]}{\left[u_c(x_3) - \frac{1}{2} u_c(x_1) \right]} \\
& + \frac{1}{2} (1 - \gamma) \pi_C \frac{[u_c(x_1) - u_c(x_3)]}{\left[u_c(x_3) - \frac{1}{2} u_c(x_1) \right]}
\end{aligned}$$

Combining these, we must have

$$q_{BC} = \frac{1}{\gamma} - \frac{(1 - \gamma) \pi_C}{\gamma \pi_B} \frac{\left(\frac{[u_c(x_1) - u_c(x_3)]}{[u_c(x_3) - \frac{1}{2} u_c(x_1)]} - \frac{[u_c(x_1) - u_c(x_2)]}{[u_c(x_2) - \frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_4)]} \right)}{\left(\frac{[\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_3) - u_c(x_2)]}{[u_c(x_2) - \frac{1}{2} u_c(x_1) - \frac{1}{2} u_c(x_4)]} - \frac{[\frac{1}{2} u_c(x_1) + \frac{1}{2} u_c(x_4) - u_c(x_3)]}{[u_c(x_3) - \frac{1}{2} u_c(x_1)]} \right)}$$

Numerical calculations confirm that this does not lie between 0 and 1 for the parameter values considered. Since none of those possibilities can exist, there cannot exist an equilibrium in mixed strategies in which voters support a candidate who took no position over a candidate who committed to B/D for the parameter values stated in this result. \square

B.4 Additional Results

Table B.1: Sample Size

		Main	Candidates Who Prefer A/E	Candidates Who Prefer B/D	Candidates Who Prefer C
Subject Candidates, No Beliefs	Low-Noise Skewed	162 (37)	12 (12)	4 (3)	8 (7)
	Low-Noise Uniform	330 (41)	11 (10)	14 (13)	15 (14)
	High-Noise Uniform	330 (41)	9 (8)	11 (9)	20 (19)
	Low-Noise Skewed	338 (46)	26 (21)	22 (16)	12 (11)
	Low-Noise Uniform	434 (59)	16 (14)	26 (23)	26 (23)
	High-Noise Uniform	436 (59)	21 (17)	22 (18)	25 (22)
Programmed Candidates, With Beliefs	Low-Noise Skewed	470 (60)			
	Low-Noise Uniform	498 (60)			
	High-Noise Uniform	496 (60)			

Table B.2: Proportion of Votes That Violated Monotonicity

		A/E vs. C	A/E vs. B/D	B/D vs. C
Subject Candidates, No Beliefs	Low-Noise Skewed	0.124*** (0.052)	0.212*** (0.073)	0.075** (0.031)
	Low-Noise Uniform	0.034* (0.018)	0.068** (0.028)	0.031** (0.015)
	High-Noise Uniform	0.037 (0.024)	0.126*** (0.040)	0.052* (0.029)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.053* (0.030)	0.161*** (0.054)	0.009* (0.005)
	Low-Noise Uniform	0.003 (0.005)	0.110*** (0.038)	0.005 (0.004)
	High-Noise Uniform	-0.003 (0.004)	0.104*** (0.037)	0.001 (0.002)
Programmed Candidates, With Beliefs	Low-Noise Skewed	0.116*** (0.033)	0.282*** (0.056)	0.043** (0.018)
	Low-Noise Uniform	0.030 (0.021)	0.188*** (0.044)	0.045** (0.020)
	High-Noise Uniform	0.031 (0.020)	0.197*** (0.044)	0.029 (0.019)
Candidate 1		0.011** (0.005)	0.057*** (0.017)	-0.001 (0.004)
R-Squared		0.08	0.22	0.04
N		3494	3494	3494
(# of subjects)		(160)	(160)	(160)
Marginal Effects				
Subject Candidates, No Beliefs		0.045* (0.024)	0.007 (0.055)	0.046** (0.018)
Programmed Candidates, With Beliefs		0.039* (0.023)	0.096 (0.059)	0.034** (0.018)
Low-Noise Skewed		0.074*** (0.018)	0.091*** (0.026)	0.011 (0.009)
High-Noise Uniform		-0.002 (0.006)	0.015 (0.011)	-0.003 (0.007)

Notes: Estimates produced by regressing a dummy for either voting for the first candidate listed or abstaining on dummies for each treatment-condition cell and a dummy for whether the candidate who took no position was labeled "Candidate 1." Standard errors clustered at the subject level. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. For A/E vs C, LS and LU are different in the no beliefs treatment (p=0.08) and the programmed candidates treatment (p=0.000). The two treatments with beliefs are different in HU (p=0.09). For A/E vs B/D, LS and LU (p=0.03) and LU and HU (p=0.02) are different in the no beliefs treatment, and LS and LU are different in the programmed candidates treatment (p=0.02). For B/D vs C, the two treatments with subject-candidates are different in LS (p=0.04) and HU (p=0.08), and the two treatments with beliefs are different in LS (p=0.07) and LU (p=0.05). Marginal effects are relative to the omitted category, which is "Subject Candidates, With Beliefs" for treatment and LU for condition.

Table B.3: Proportion of Votes That Were For A Candidate Who Took No Position Over A Candidate Who Committed To B/D: Low Response Error

		(1)	(2)	(3)	(4)
Subject Candidates, No Beliefs	Low-Noise Skewed	0.098** (0.043)	0.098** (0.043)	0.122** (0.052)	0.122** (0.052)
	Low-Noise Uniform	0.150** (0.068)	0.150** (0.068)	0.163** (0.081)	0.163** (0.081)
	High-Noise Uniform	0.230*** (0.078)	0.230*** (0.078)	0.268*** (0.091)	0.268*** (0.091)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.027** (0.012)	0.027** (0.013)	0.028** (0.012)	0.029** (0.014)
	Low-Noise Uniform	0.064*** (0.020)	0.064*** (0.019)	0.062*** (0.021)	0.062*** (0.019)
	High-Noise Uniform	0.214*** (0.049)	0.214*** (0.049)	0.203*** (0.047)	0.203*** (0.047)
Programmed Candidates, With Beliefs	Low-Noise Skewed	0.304*** (0.081)	0.304*** (0.081)	0.315*** (0.083)	0.315*** (0.083)
	Low-Noise Uniform	0.293*** (0.079)	0.293*** (0.079)	0.296*** (0.081)	0.296*** (0.081)
	High-Noise Uniform	0.324*** (0.078)	0.324*** (0.078)	0.332*** (0.080)	0.332*** (0.080)
Candidate 1			-0.000 (0.011)		-0.001 (0.011)
R-Squared		0.25	0.25	0.26	0.26
N		2076	2076	1916	1916
(# of subjects)		(96)	(96)	(88)	(88)
Marginal Effects					
Subject Candidates, No Beliefs		0.056 (0.061)	0.056 (0.061)	0.086 (0.070)	0.086 (0.070)
Programmed Candidates, With Beliefs		0.199*** (0.075)	0.199*** (0.075)	0.211*** (0.076)	0.211*** (0.076)
Low-Noise Skewed		-0.024 (0.031)	-0.024 (0.031)	-0.016 (0.033)	-0.016 (0.033)
High-Noise Uniform		0.091*** (0.025)	0.091*** (0.025)	0.094*** (0.026)	0.094*** (0.026)

Notes: The dependent variable is a dummy for voting for the candidate who took no position when the opponent committed to B or D. Models estimated using OLS. The sample is restricted to subjects who violated monotonicity at most once. Subjects who made choices in the binary risky decision task consistent with $\alpha \geq 0.305$ are excluded from the sample in models 3 and 4. Standard errors clustered at the subject level. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. Differences between LU and HU are significant in the subject-candidates with beliefs treatment ($p < 0.002$). The difference between the treatments with subject-candidates in LS is significant in (3) and (4) only ($p < 0.09$). Differences between the two treatments with beliefs are significant within LS and LU ($p < 0.01$). Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, With Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform."

Table B.4: Individual Voter Choices Between A Candidate Who Took No Position and A Candidate Who Committed to B/D: 70 Percent Cutoff

Vote Pattern			Subject- Candidates, No Beliefs	Subject-, Candidates With Beliefs	Programmed Candidates, With Beliefs	Cumulative Probability
LS	LU	HU				
B/D or -	B/D	B/D	24	35	21	66.1
B/D or -	B/D	~	2	6	3	75.2
B/D or -	B/D	n.p.	3	1	3	81.0
B/D	~	n.p.	0	0	1	81.8
B/D	n.p.	n.p.	0	0	3	84.3
~	n.p.	n.p.	1	0	1	86.0
-	n.p.	n.p.	5	0	0	90.1
n.p.	n.p.	n.p.	0	1	11	100
Not categorized			1	12	13	

Notes: LS, LU, and HU denote the low-noise skewed, low-noise uniform, and high-noise uniform conditions, respectively. Within each condition, a subject is said to vote for a candidate if she cast at least 70 percent of her votes during those periods for that candidate. Subjects who made choices in the binary risky decision task consistent with a coefficient of absolute risk aversion $\alpha \geq 0.305$ are classified as too risk-averse and not included here. "-" indicates missing data for that condition due to the programming error.

Table B.5: Beliefs About The Strategy Chosen By A Candidate Who Prefers A/E

		Commit To A/E	Commit To B/D	Commit To C	No Position
Programmed Candidates, With Beliefs	Low-Noise Skewed	0.678*** (0.034)	0.080*** (0.012)	0.132*** (0.019)	0.110*** (0.023)
	Low-Noise Uniform	0.586*** (0.039)	0.097*** (0.013)	0.184*** (0.027)	0.133*** (0.029)
	High-Noise Uniform	0.562*** (0.038)	0.080*** (0.011)	0.167*** (0.027)	0.191*** (0.027)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.390*** (0.049)	0.194*** (0.030)	0.199*** (0.032)	0.218*** (0.037)
	Low-Noise Uniform	0.338*** (0.042)	0.180*** (0.028)	0.237*** (0.033)	0.245*** (0.036)
	High-Noise Uniform	0.327*** (0.039)	0.141*** (0.022)	0.247*** (0.032)	0.284*** (0.033)
R-squared		0.73	0.43	0.44	0.43
N		2676	2676	2676	2676
(# of subjects)		(119)	(119)	(119)	(119)
Actual Subject- Candidate Strategies	Low-Noise Skewed	0.421*** (0.081)	0.368*** (0.083)	0.105** (0.047)	0.105** (0.052)
	Low-Noise Uniform	0.444*** (0.101)	0.370*** (0.095)	0.074 (0.050)	0.111* (0.060)
	High-Noise Uniform	0.333*** (0.082)	0.333*** (0.086)	0.167** (0.077)	0.167** (0.067)
Average Marginal Effects					
Programmed Candidates, With Beliefs		0.255*** (0.052)	-0.085*** (0.026)	-0.066* (0.037)	-0.104*** (0.040)
Low-Noise Skewed		0.074*** (0.022)	-0.003 (0.011)	-0.046*** (0.016)	-0.025 (0.017)
High-Noise Uniform		-0.018 (0.013)	-0.027*** (0.007)	-0.004 (0.010)	0.049*** (0.014)

Notes: Top panel: estimates produced by regressing subjects' stated beliefs that a candidate who prefers A/E chooses each possible campaign strategy on dummies for each treatment cell. Second panel: estimates produced by regressing dummies for whether a subject-candidate chose each possible campaign strategy on dummies for each condition. Standard errors clustered at the subject level. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, With Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform."

Table B.6: Beliefs About The Strategy Chosen By A Candidate Who Prefers B/D

		Commit To A/E	Commit To B/D	Commit To C	No Position
Programmed Candidates, With Beliefs	Low-Noise Skewed	0.113*** (0.018)	0.638*** (0.036)	0.146*** (0.020)	0.103*** (0.022)
	Low-Noise Uniform	0.090*** (0.014)	0.617*** (0.036)	0.184*** (0.026)	0.109*** (0.023)
	High-Noise Uniform	0.080*** (0.012)	0.585*** (0.035)	0.171*** (0.027)	0.163*** (0.022)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.064*** (0.020)	0.615*** (0.038)	0.258*** (0.033)	0.063*** (0.009)
	Low-Noise Uniform	0.028*** (0.007)	0.592*** (0.033)	0.294*** (0.031)	0.085*** (0.015)
	High-Noise Uniform	0.025*** (0.006)	0.537*** (0.032)	0.307*** (0.030)	0.131*** (0.016)
R-squared		0.31	0.83	0.53	0.37
N		2684	2684	2684	2684
(# of subjects)		(119)	(119)	(119)	(119)
Actual Subject- Candidate Strategies	Low-Noise Skewed	0 (-)	0.769*** (0.078)	0.231*** (0.078)	0 (-)
	Low-Noise Uniform	0 (-)	0.675*** (0.074)	0.275*** (0.070)	0.050 (0.035)
	High-Noise Uniform	0 (-)	0.697*** (0.090)	0.242*** (0.087)	0.061 (0.043)
Average Marginal Effects					
Programmed Candidates, With Beliefs		0.055*** (0.016)	0.033 (0.045)	-0.120*** (0.036)	0.032 (0.023)
Low-Noise Skewed		0.029*** (0.010)	0.022 (0.020)	-0.037** (0.030)	-0.013 (0.010)
High-Noise Uniform		-0.007 (0.005)	-0.043*** (0.012)	-0.001 (0.010)	0.050*** (0.010)

Notes: Top panel: estimates produced by regressing subjects' stated beliefs that a candidate who prefers B/D chooses each possible campaign strategy on dummies for each treatment cell. Second panel: estimates produced by regressing dummies for whether a subject-candidate chose each possible campaign strategy on dummies for each condition. Standard errors clustered at the subject level. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, With Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform."

Table B.7: Beliefs About The Strategy Chosen By A Candidate Who Prefers C

		Commit To A/E	Commit To B/D	Commit To C	No Position
Programmed Candidates, With Beliefs	Low-Noise Skewed	0.107*** (0.019)	0.064*** (0.012)	0.783*** (0.033)	0.045*** (0.006)
	Low-Noise Uniform	0.081*** (0.015)	0.077*** (0.014)	0.787*** (0.030)	0.056*** (0.008)
	High-Noise Uniform	0.068*** (0.012)	0.067*** (0.011)	0.742*** (0.031)	0.123*** (0.015)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.045** (0.019)	0.020*** (0.008)	0.897*** (0.026)	0.037*** (0.008)
	Low-Noise Uniform	0.016*** (0.005)	0.024*** (0.007)	0.934*** (0.016)	0.026*** (0.006)
	High-Noise Uniform	0.014*** (0.005)	0.018*** (0.006)	0.896*** (0.018)	0.072*** (0.014)
R-Squared		0.28	0.29	0.94	0.41
N		2676 (119)	2676 (119)	2676 (119)	2676 (119)
Actual Subject- Candidate Strategies	Low-Noise Skewed	0 (-)	0 (-)	1.000*** (0.000)	0 (-)
	Low-Noise Uniform	0 (-)	0.024 (0.025)	0.951*** (0.034)	0.024 (0.025)
	High-Noise Uniform	0 (-)	0 (-)	0.956*** (0.044)	0.044 (0.044)
Average Marginal Effects					
Programmed Candidates, With Beliefs		0.060*** (0.016)	0.049*** (0.013)	-0.139*** (0.034)	0.030*** (0.012)
Low-Noise Skewed		0.028*** (0.011)	-0.009 (0.005)	-0.018 (0.015)	-0.001 (0.005)
High-Noise Uniform		-0.008** (0.004)	-0.008** (0.004)	-0.041*** (0.009)	0.058*** (0.008)

Notes: Top panel: estimates produced by regressing subjects' stated beliefs that a candidate who prefers C chooses each possible campaign strategy on dummies for each treatment cell. Second panel: estimates produced by regressing dummies for whether a subject-candidate chose each possible campaign strategy on dummies for each condition. Standard errors clustered at the subject level. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, With Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform."

Table B.8: Actual Behavior of Subject-Candidates

Preferred Policy	Condition	Commit To A/E	Commit To B/D	Commit To C	No Position
Subject-Candidates, No Beliefs					
A	Low-Noise Skewed	0.417*** (0.147)	0.333** (0.141)	0.083 (0.083)	0.167 (0.111)
	Low-Noise Uniform	0.455*** (0.141)	0.364** (0.158)	0.091 (0.081)	0.091 (0.091)
	High-Noise Uniform	0.333** (0.143)	0.222 (0.148)	0.222* (0.127)	0.222 (0.148)
B	Low-Noise Skewed	0 (-)	1 (-)	0 (-)	0 (-)
	Low-Noise Uniform	0 (-)	0.714*** (0.116)	0.286** (0.116)	0 (-)
	High-Noise Uniform	0 (-)	0.364** (0.165)	0.545*** (0.177)	0.091 (0.091)
C	Low-Noise Skewed	0 (-)	0 (-)	1*** (0.000)	0 (-)
	Low-Noise Uniform	0 (-)	0.067 (0.067)	0.867*** (0.092)	0.067 (0.067)
	High-Noise Uniform	0 (-)	0 (-)	0.900*** (0.096)	0.100 (0.096)
Subject-Candidates, With Beliefs					
A	Low-Noise Skewed	0.423*** (0.100)	0.385*** (0.104)	0.115** (0.058)	0.077 (0.055)
	Low-Noise Uniform	0.438*** (0.144)	0.375*** (0.122)	0.063 (0.063)	0.125 (0.081)
	High-Noise Uniform	0.333*** (0.101)	0.381*** (0.106)	0.143 (0.097)	0.143* (0.077)
B	Low-Noise Skewed	0 (-)	0.727*** (0.090)	0.273*** (0.090)	0 (-)
	Low-Noise Uniform	0 (-)	0.654*** (0.097)	0.269*** (0.089)	0.077 (0.055)
	High-Noise Uniform	0 (-)	0.864*** (0.070)	0.091 (0.058)	0.045 (0.046)
C	Low-Noise Skewed	0 (-)	0 (-)	1*** (0.000)	0 (-)
	Low-Noise Uniform	0 (-)	0 (-)	1*** (0.000)	0 (-)
	High-Noise Uniform	0 (-)	0 (-)	1*** (-)	0 (-)
Average Marginal Effects					
Policy Preference A/E		0.398*** (0.066)	0.344*** (0.063)	-0.851*** (0.043)	0.109** (0.048)
Policy Preference B/D		0 (-)	0.704*** (0.049)	-0.723*** (0.054)	0.018 (0.030)
Subject Candidates, With Beliefs		-0.001 (0.041)	-0.038 (0.055)	-0.002 (0.052)	-0.035 (0.040)
Low-Noise Skewed		-0.007 (0.038)	-0.034 (0.046)	0.003 (0.038)	-0.030 (0.027)
High-Noise Uniform		-0.035 (0.035)	-0.008 (0.051)	0.019 (0.037)	0.024 (0.035)

Table B.8 – continued from previous page

Notes: The dependent variable is a dummy equal to 1 if the candidate chose to commit to A/E, commit to B/D, commit to C, and take no position and zero otherwise in columns 1, 2, 3, and 4, respectively. This is regressed on triple interactions of candidate type with treatment and condition. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. The R^2 is 0.41, 0.61, 0.78, and 0.12 when the dependent variable is whether the candidate chose A/E, B/D, C, and no position, respectively. Standard errors clustered at the subject level. N=300 with 91 subjects. Marginal effects are relative to the omitted category. The omitted candidate policy preference is C. For effects of treatment, the omitted category is "Subject Candidates, No Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform." Pooling all treatments and conditions together, candidates who prefer A/E and those who prefer B/D differ in terms of the probability of choosing to commit to A/E ($p=0.000$), choosing to commit to B/D ($p=0.000$), and choosing to commit to C ($p=0.017$), and taking no position ($p=0.048$).

Table B.9: Beliefs About A Candidate Who Took No Position

		Probability He Prefers A/E	Probability He Prefers B/D	Probability He Prefers C
Subject Candidates, With Beliefs	Low-Noise	0.576***	0.187***	0.237***
	Skewed	(0.041)	(0.020)	(0.038)
	Low-Noise	0.546***	0.228***	0.225***
	Uniform	(0.038)	(0.019)	(0.034)
	High-Noise	0.487***	0.253***	0.258***
Programmed Candidates, With Beliefs	Uniform	(0.032)	(0.016)	(0.034)
	Low-Noise	0.486***	0.236***	0.277***
	Skewed	(0.019)	(0.012)	(0.021)
	Low-Noise	0.346***	0.297***	0.355***
	Uniform	(0.021)	(0.014)	(0.028)
R-Squared	High-Noise	0.337***	0.303***	0.357***
	Uniform	(0.019)	(0.013)	(0.024)
N		0.81	0.80	0.61
		2680	2680	2680
Based on Actual Behavior of Subject- Candidates		(119)	(119)	(119)
	Low-Noise	0.661	0.169	0.170
	Skewed			
	Low-Noise	0.428	0.311	0.261
	Uniform			
Based on Actual Behavior of Programmed Candidates	High-Noise	0.393	0.309	0.297
	Uniform			
	Low-Noise	0.909	0.045	0.045
	Skewed			
	Low-Noise	0.833	0.083	0.083
	Uniform			
	High-Noise	0.667	0.167	0.167
	Uniform			
Marginal Effects				
Programmed Candidates, With Beliefs		-0.149***	0.056***	0.092**
		(0.038)	(0.020)	(0.040)

Table B.9 – continued from previous page

	Probability He Prefers A/E	Probability He Prefers B/D	Probability He Prefers C
Low-Noise Skewed	0.090*** (0.016)	-0.052*** (0.010)	-0.037** (0.015)
High-Noise Uniform	-0.031*** (0.009)	0.015** (0.007)	0.016* (0.010)

Notes: The dependent variable in each column is the probability that the subject assigned to a candidate who took no position having preferred policy A/E, B/D, and C, respectively. This is regressed using OLS on dummies for each treatment-condition cell. Standard errors clustered at the subject level. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. Mean $\tilde{\pi}_{A|n}$ is statistically different between LU and HU in the subject-candidates treatment ($p=0.002$) and between LS and LU in the programmed candidates treatment ($p=0.000$), between the two treatments in LS ($p=0.05$) and LU and HU ($p=0.000$). Mean $\tilde{\pi}_{B|n}$ is statistically different between LS and LU ($p=0.042$) and between LU and HU ($p=0.053$) in the subject-candidates treatment, between LS and LU in the programmed candidates treatment ($p=0.000$), and between treatments in LS ($p=0.036$), LU ($p=0.004$), and HU ($p=0.015$). Mean $\tilde{\pi}_{C|n}$ is statistically different between LU and HU in the subject-candidates treatment ($p=0.051$), between LS and LU in the programmed candidates treatment ($p=0.000$), and between treatments in LU ($p=0.004$) and HU ($p=0.020$). Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, With Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform."

Table B.10: Proportion of Votes That Were For A Candidate Who Committed to A/E Over a Candidate Who Took No Position: Low Response Error

		(1)	(2)	(3)	(4)
Subject Candidates, No Beliefs	Low-Noise Skewed	0.235** (0.094)	0.237** (0.094)	0.268** (0.110)	0.271** (0.110)
	Low-Noise Uniform	0.265*** (0.083)	0.266*** (0.083)	0.259*** (0.092)	0.262*** (0.091)
	High-Noise Uniform	0.245*** (0.081)	0.246*** (0.081)	0.238*** (0.089)	0.241*** (0.089)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.237*** (0.073)	0.238*** (0.073)	0.245*** (0.077)	0.248*** (0.077)
	Low-Noise Uniform	0.199*** (0.059)	0.200*** (0.059)	0.209*** (0.063)	0.212*** (0.063)
	High-Noise Uniform	0.162*** (0.057)	0.164*** (0.057)	0.175*** (0.061)	0.178*** (0.061)
Programmed Candidates, With Beliefs	Low-Noise Skewed	0.088* (0.047)	0.089* (0.047)	0.091* (0.049)	0.094* (0.049)
	Low-Noise Uniform	0.089* (0.051)	0.091* (0.051)	0.092* (0.053)	0.095* (0.053)
	High-Noise Uniform	0.143** (0.059)	0.145** (0.059)	0.147** (0.060)	0.150** (0.060)
Candidate 1			-0.003 (0.007)		-0.006 (0.007)
R-Squared		0.20	0.20	0.20	0.20
N		2076	2076	1916	1916
(# of subjects)		(96)	(96)	(88)	(88)
Marginal Effects					
Subject Candidates, No Beliefs		0.054 (0.096)	0.054 (0.096)	0.047 (0.104)	0.047 (0.104)
Programmed Candidates, With Beliefs		-0.087 (0.076)	-0.087 (0.076)	-0.095 (0.080)	-0.095 (0.080)
Low-Noise Skewed		0.008 (0.027)	0.008 (0.027)	0.017 (0.029)	0.017 (0.029)
High-Noise Uniform		-0.001 (0.021)	-0.001 (0.021)	0.002 (0.023)	0.002 (0.023)

Notes: The dependent variable is a dummy for voting for the candidate who committed to A/E or abstaining when the opponent took no position. Models estimated using OLS. The sample is restricted to subjects who violated monotonicity at most once. Subjects who made choices in the binary risky decision task consistent with $\alpha \geq 0.305$ are excluded from the sample in models 3 and 4. Standard errors clustered at the subject level. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. The treatment with subject-candidates with beliefs and the programmed candidates treatment are statistically different in LS in all specifications ($p < 0.10$). Marginal effects are relative to the omitted category. For effects of treatment, the omitted category is "Subject Candidates, With Beliefs"; for effects of condition, the omitted category is "Low-Noise Uniform."

Table B.11: Proportion of Votes That Were For A Candidate Who Committed To A/E Over A Candidate Who Took No Position : Control for Last Period

		(1)	(2)	(3)	(4)
Subject Candidates, No Beliefs	Low-Noise Skewed	0.472*** (0.094)	0.482*** (0.094)	0.532*** (0.100)	0.543*** (0.100)
	Low-Noise Uniform	0.394*** (0.070)	0.404*** (0.071)	0.417*** (0.076)	0.428*** (0.076)
	High-Noise Uniform	0.347*** (0.067)	0.357*** (0.067)	0.361*** (0.073)	0.372*** (0.073)
Subject Candidates, With Beliefs	Low-Noise Skewed	0.418*** (0.072)	0.428*** (0.072)	0.436*** (0.075)	0.446*** (0.075)
	Low-Noise Uniform	0.312*** (0.058)	0.322*** (0.058)	0.330*** (0.061)	0.341*** (0.061)
	High-Noise Uniform	0.297*** (0.059)	0.307*** (0.060)	0.316*** (0.062)	0.326*** (0.063)
Programmed Candidates, With Beliefs	Low-Noise Skewed	0.320*** (0.055)	0.330*** (0.056)	0.318*** (0.057)	0.329*** (0.058)
	Low-Noise Uniform	0.253*** (0.055)	0.263*** (0.056)	0.251*** (0.056)	0.262*** (0.057)
	High-Noise Uniform	0.245*** (0.049)	0.255*** (0.050)	0.246*** (0.050)	0.257*** (0.051)
Last Period of Experiment		-0.037 (0.044)	-0.037 (0.044)	-0.036 (0.045)	-0.036 (0.045)
Candidate 1			-0.021* (0.011)		-0.022* (0.011)
R-Squared		0.33	0.33	0.35	0.35
N		3494	3494	3222	3222
(# of subjects)		(160)	(160)	(147)	(147)

Notes: The dependent variable is a dummy for voting for the candidate who committed to A/E or abstaining when the opponent took no position. Models estimated using OLS. The dummy for "last period of experiment" is equal to 1 if the vote occurred during the 5th period of the last condition. Subjects who made choices in the binary risky decision task consistent with $\alpha \geq 0.305$ are excluded from the sample in models 3 and 4. Standard errors clustered at the subject level. *, **, and *** indicate that a coefficient is statistically different from zero at the 10%, 5%, and 1% level, respectively. LS and LU are different in the subject-candidates with beliefs treatment ($p < 0.05$) and in the programmed candidates treatment ($p < 0.10$).

APPENDIX C
APPENDIX TO CHAPTER 3

C.1 Aspects of Well-Being

Here we describe the process of compiling our initial master list of 136 "aspect of well-being" survey measures; the measures are listed below, together with references to the literature. We then describe how we created two additional list versions from the first 108 aspect measures.

Subsection C.1.1 lists the six broad classes from which our 136 aspects were generated; subsection C.1.2 lists the considerations that affected how we phrased the aspects; subsection C.1.3 provides a legend to the abbreviated references that accompany the aspect list; and subsection C.1.4 provides the master list itself.

Subsection C.1.5 then explains how we divided our master list of 136 aspects into 108 *you-*, 5 *you-only-*, and 23 *public-*aspects, and how we modified the *you-*aspects (the first 108 aspects on the master list) to create 108 *everyone-*aspects that apply to everyone in the nation and 108 *others-*aspects that apply to others in the nation (as explained in the main text, *others-*aspects appear in scenarios that are not analyzed in the paper). Finally, these latter two modified lists are reported in subsections C.1.6 and C.1.7, respectively.

C.1.1 Classes of Measures of Aspects of Well-Being

There are six classes of survey measures that we include:

1. *Single-question survey measures of SWB.* Since most of the evidence in the happiness literature to date is based on single-question SWB measures, it is important that our list, which explicitly looks beyond traditional SWB

measures, also include an extensive set of versions of such traditional measures. We hence include measures modeled after the SWB questions most commonly used in large-scale social surveys. These include, for example, those asked in or proposed for the U.K. survey discussed in the Introduction.¹ We include both cognitive, evaluative SWB measures (e.g., life satisfaction) and affective, hedonic ones (including an array of positive and negative emotions).

2. *Multi-question survey measures of SWB.* While empirical work in economics relies heavily on single-question survey measures, much research in psychology uses multi-question scales, such as the PANAS (Positive And Negative Affect Scale) and the GHQ (General Health Questionnaire, a measure of mental health). In addition to measures modeled after questions comprising these scales, we also included measures based on questions comprising the Scale of Positive and Negative Experience (SPANE), the Affect Balance Scale (ABS), and the Health and Retirement Study's Psychosocial Leave-Behind.
3. *Aspects of well-being proposed by prominent economists, psychologists, and philosophers.* This class comprises by far the largest subset of our list. To the best of our knowledge, our effort reflects the most systematic attempt to date to gather aspects from prominent works—all of which explicitly compose lists of specific factors that are proposed to be important determinants of well-being—and compile them all into one list. While the past work we consulted is but a sample of a much broader body of research, we hope it is a sample chosen carefully enough to make the resulting list relatively comprehensive.

We started with the list proposed by the Stiglitz Commission (officially, "the Commission on the Measurement of Economic Performance and Social Progress"). The French government convened the commission at the

¹

Hence, we draw from documents that propose questions for the U.K. survey beyond the four questions that were ultimately selected. These are Dolan, Layard, and Metcalfe's (2011) Office for National Statistics (ONS) publication and Deaton, Kahneman, Krueger, Schkade, Schwarz, and Stone's (2011) memo to the ONS's Advisory Group on Subjective Well-Being.

beginning of 2008 with official aims that included "to identify the limits of GDP as an indicator of economic performance and social progress" and "to consider additional information required for the production of a more relevant picture." The commission's final report (Stiglitz, Sen, and Fitoussi, 2009) emphasizes the view that "well-being is multi-dimensional" and details what its members—among whom are prominent well-being researchers, mostly from economics but also from other disciplines such as psychology and political science—view as well-being's most important dimensions.² We compiled an initial list that included the dimensions suggested in the report, and then broke them down into sub-dimensions specific enough that we could fit them into our survey as "aspect of well-being" questions. In this zooming-in process we consulted specific works by members of the commission (e.g., Kahneman and Deaton, 2010) to verify that our aspects use language that is as close as possible to the language used in past survey research.

Another candidate set of factors that matter for well-being, also an input into the commission's composition and conclusions, was Sen's (1985) and Nussbaum's (2000) lists of "functionings" and "capabilities," which we used to expand our list of aspects, and to create new aspects if they were not previously on our list.

A third candidate was Maslow's (1946) theory of human motivation, which includes the famous pyramid of needs and a list of what he views as motivating "desires."

We also consulted recent work in the psychology literature that attempts

2

For example, the commission's report states (Stiglitz et al., 2009, pp. 14-15): "To define what well-being means, a multidimensional definition has to be used. Based on academic research and a number of concrete initiatives developed around the world, the Commission has identified the following key dimensions that should be taken into account. At least in principle, these dimensions should be considered simultaneously: i. Material living standards (income, consumption and wealth); ii. Health; iii. Education; iv. Personal activities including work[;] v. Political voice and governance; vi. Social connections and relationships; vii. Environment (present and future conditions); viii. Insecurity, of an economic as well as a physical nature. All these dimensions shape people's well-being, and yet many of them are missed by conventional income measures."

to look beyond happiness when breaking down the notion of psychological well-being into more basic components (e.g., Ryff, 1989). We paid special attention to Seligman's enumeration of what constitutes well-being ("authentic happiness"). We especially focused on Seligman's work that is aimed at informing policy (e.g., Diener and Seligman, 2004). We also checked that our resulting list did not miss aspects proposed by other recent enumerations of factors by confirming, for example, that it covered the main factors in Loewenstein and Ubel's (2008) public policy recommendations.

Finally, to verify that our list covers the recent academic literature relatively comprehensively, we trained eleven research assistants (RAs) to carefully read through papers and books, highlighting passages that explicitly or implicitly identified key aspects of well-being and recording those aspects of well-being in a spreadsheet. Initially, we instructed two RAs about how to do this. The instruction process included several meetings in which we went over a few papers together; demonstrated to the RAs what we wanted them to do; then gave them a few days to do it themselves; and then met again to go over what they did, answer questions, and provide feedback. The RA training process consisted, first, of three initial training hours of the two RAs by the authors of this paper. Second, these two RAs wrote a training document (available upon request) that very briefly summarizes what they did, and which they used in training the nine additional RAs. Third, the authors then met twice with the entire set of eleven RAs to go over examples of work that had been done in the early weeks of the project and answer questions.

Overall, over the course of June-September, 2011, the eleven RAs covered 34 articles and four books, which are listed, along with the other works we drew on, in subsection C.1.3 below. We started with an initial set of papers and books that we were aware of (e.g., Alkire, 2002) as well as work referenced in the initial set, work referenced in the referenced work, etc. The resulting RAs' spreadsheet of proposed aspects and highlighted articles are available as Supplementary Materials to this paper. From this

spreadsheet, we culled many additional aspects.

Finally, we trained two new RAs to read through John Rawls's *Theory of Justice*, a major work we had omitted earlier (and subsequently read). While we did not add new aspects on the basis of this book, we verified that we had not missed important ones.

4. *Our own introspection and discussion.* We further extended and refined the list both by drawing on our own previous research (Benjamin, Heffetz, Kimball, and Rees-Jones, 2012), which aimed to empirically identify aspects in addition to own happiness that help predict survey respondents' hypothetical choices; and by drawing on our own introspection regarding the factors that enter preferences, inspired in part by our reading of nonacademic writers and by extensive conversations among ourselves and with colleagues.

In many cases, seemingly-similar but differently-worded aspects coming from these four classes were both candidates for inclusion in the list. To determine whether two candidate aspects, A and B, were distinct, we attempted to formulate examples where a person might want something that is an example of B but which cannot be considered an example of A (or at least in the spirit of A), and vice versa, switching A and B. If we could formulate such examples, we considered A and B to be distinct.

In other cases, we judged that valuable things proposed by researchers (from class 3 above) were not "fundamental." We then attempted to come up with the fundamental aspects that explain why someone would want that thing. For example, it is often claimed that religion contributes to happiness and well-being. We refined "religion" into several aspects of well-being that may help explain the value of religion but which are also valued by many non-religious people, such as aspects 91-96 and 101-108, including "you having people around you who share your values, beliefs and interests," "your opportunities to participate in ceremonies, cultural events, and celebrations that are meaningful to you" and "your sense of connection with the universe or the power behind the universe."

5. *New combination aspects that might be "summary measures" of well-being.* In addition to trying to compile a list of fundamental things that many people want, we also sought to come up with a single measure that, all by itself, would be as highly correlated as possible with stated preference. We conceptualize such a "summary measure" not as a fundamentally-valued aspect of well-being (i.e., not as an element of the \mathbf{w} vector in the theory), but rather as a particular survey question that might cause respondents, when responding to it, to take into account the great variety of aspects they consider when making choices. In terms of the theory, we think of a summary measure as eliciting an especially broad combination aspect, i.e., the answer to a single question that yields a function of many of the elements of \mathbf{w} and that might have an especially high correlation with choice. We consider some of the existing SWB measures, such as "how happy you feel during your life," "how satisfied you are with your life," and "how close your life is to being ideal" to be candidate summary measures. We also formulated summary measures that, as far as we know, have not been used previously in surveys, e.g., "how much you like your life" and "the overall well-being of you and your family." Since we took the view that our ability to predict *a priori* which measure would have the highest correlation with choice is severely limited, this class accounts for a large number of questions.
6. *Subjective versions of "objective" measures of well-being.* We additionally sought to include a few "objective" measures that—while not considered by us or others to be fundamentally-valued aspects of life—are often used by economists and policymakers as proxies for well-being. For this purpose, we included questions about total GDP, GDP per capita, GDP growth, the unemployment rate, the inflation rate, income equality, longevity, and health. Of course, our survey questions refer to *subjective perceptions* of these quantities, rather than their objective levels. Nonetheless, by including them, we can assess how people weight these objective measures compared with the subjective measures we include.

At the boundary of this class are subjective evaluations of an individual's

constraints and feasible choice set, such as "feeling that you have enough time and money for the things that are most important to you" and "having many options and possibilities in your life and the freedom to choose among them." We felt that such measures might point to fundamental desirable perceptions—i.e., perceptions that people would like to have regardless of whether they take advantage of the perceived choices and even regardless of whether they objectively have these choices—as well as indicate how much of other aspects seem obtainable. (The aspect "having many options and possibilities" also belongs to class 3 above, as it has been proposed by Sen, Nussbaum, and others.)

A primary criterion for not including an aspect on our list, even if we felt it was fundamental, was if experiencing that aspect would require either supernatural power or technology that is currently unavailable. For example, we excluded "your freedom from death" even though it seems to be a fundamentally-desired thing and, arguably, a motivating factor in some people's behavior. Similarly, we excluded all afterlife aspects.

C.1.2 Aspects of Well-Being: Phrasing

We had a number of considerations when deciding how to phrase an aspect. We tried to:

- *Phrase in the context of specific choices.* Doing so enables us to compare aspects with each other as consequences of, as affected by, and as motivating choices (i.e., as relevant arguments in the utility function).
- *Phrase in a way that allows for a limited-time-frame interpretation.* Doing so enables us to elicit the "single period" effects of stated choices, thereby alleviating concerns that would result, e.g., from cross-respondent differences in time integration. Thus, for example, we avoided phrases such as "during your lifetime."

- *Orient so that rating higher would conventionally be considered desirable.* Doing so likely reduces respondent confusion and thereby reduces errors and shortens survey time. For example, instead of asking about "how anxious you feel," we ask about "you not feeling anxious."
- *Write in language that would be understandable by most survey respondents in a national sample.* In some cases, we put several different phrases in the same question that were not synonymous, but which we thought were closely enough associated that they would clarify each other's meaning and clarify the spirit of what we were asking.
- *For aspects 1-108: phrase in a way that minimizes changes to text when switching between "you," "others," and "people."* Doing so allows us to easily incorporate other-regarding preferences, for example, to replace "how happy you feel" with "how happy others feel" or with "how happy people feel." (See subsection C.1.5 below.)
- *For closely-related aspects: combine into a single question.* While ideally we would include each distinct aspect as a separate survey question, we felt that combining closely-related aspects was a reasonable compromise that allowed us to cover more ground in our constrained amount of survey time.
- *For existing survey questions: word as closely as possible to the original question.* Doing so makes the analysis of our question as informative as possible regarding the existing question.

In some cases we were forced to trade off between these goals. For example, we phrased the aspect modeled after the U.K. survey question "Overall, how anxious did you feel yesterday?" as "you not feeling anxious."

C.1.3 Aspects of Well-Being Origin: Legend

To facilitate tracking the origin of each aspect on our list, we indicate relevant references in the parentheses next to each aspect. In some cases—e.g., "your free-

dom from pain," "your material standard of living," or "you being a good, moral person and living according to your personal values"—where the importance of the aspect is highlighted by virtually an entire body of literature, the references we list are merely examples.

Corresponding to aspect classes 1-6 (see C.1.1 above), we use the following abbreviations:

Aspect Class 1.

SWB We use this abbreviation to indicate aspects modeled after SWB measures used in large-scale surveys, including: the Euro-Barometer Survey; the European Social Survey; the German Socioeconomic Panel; the Japanese Life in Nation survey; the U.S.-based Gallup-Healthways Well-Being Index, General Social Survey, Health and Retirement Study, National Survey of Families and Households, and Survey of Consumers; and the World Values Survey.

Aspect Classes 2., 3., and 4. We use the following abbreviations:

- AHC** **Anand, Paul et al.** 2009. "The Development of Capability Indicators." *Journal of Human Development and Capabilities*, 10(1): 125-152.
- BMP** **Bauer, Jack J., Dan P. McAdams, and Jennifer L. Pals.** 2008. "Narrative Identity and Eudaimonic Well-Being." *Journal of Happiness Studies*, 9: 81-104.
- BHKR** **Benjamin, Daniel J., Ori Heffetz, Miles S. Kimball, and Alex Rees-Jones.** 2012. "What Do You Think Would Make You Happier? What Do You Think You Would Choose?" *American Economic Review*, 102(5): 2083-2110.
- BC** **Bliss, Christopher.** 1993. "Life Style and the Standard of Living." *The Quality of Life*. Ed. Martha Nussbaum and Amartya Sen. New York: Oxford University Press.

- ABS** **Bradburn, Norman M.** 1969. *Structure of Psychological Well-Being*. Chicago: Aldine Pub. Co.
Note: The aspects that cite Bradburn (1969) are part of the Affect Balance Scale (ABS) developed in that work.
- BBM** **Bronsteen, John, Christopher J. Buccafusco, and Jonathan S. Masur.** 2010. "Welfare as Happiness." *Georgetown Law Journal*, 98: 1583.
- BD** **Brooks, David.** 2011. *The Social Animal: the hidden sources of love, character, and achievement*. New York: Random House.
- CR** **Cummins, Robert A.** 1996. "The Domains of Life Satisfaction: An Attempt to Order Chaos." *Social Indicators Research*, 38(3): 303-328.
- DKS** **Deaton, Angus, Daniel Kahneman, Alan Krueger, David Schkade, Norbert Schwarz, and Arthur Stone.** 2011. Memo to the Office of National Statistics Advisory Group on Subjective Well-Being. Published in the Supporting Documents for the Meeting to Provide Guidance to the Organisation for Economic Co-operation and Development on its Plans to Measure Self- Reported Well-Being held on July 8, 2011.
- DCG** **Devine, Joseph, Laura Camfield, and Ian Gough.** 2008. "Autonomy or Dependence—Or Both?: Perspectives from Bangladesh." *Journal of Happiness Studies*, 9:105-138.
- DE** **Diener, Ed.** 2000. "Subjective Well-Being: The Science of Happiness and a Proposal for a National Index." *American Psychologist*, 55(1): 34-43.
or
Diener, Ed, Richard Lucas, Ulrich Schimmack, and John Helliwell. 2009. *Well-Being for Public Policy*. New York: Oxford University Press.
or
Diener, Ed, Derrick Wirtz, William Tov, Chu Kim-Prieto, Dongwon Choi, Shigehiro Oishi, and Robert Biswas-Diener. 2010. "New Well-Being Measures: Short Scales to Assess Flourishing and Positive and Negative Feelings." *Social Indicators Research*, 97(2): 143-156.

Note: Some of the aspects that cite Diener and co-authors are from the Flourishing Scale and the SPANE Scale, and that is indicated.

- DS** **Diener, Ed and Martin E.P. Seligman.** 2004. "Beyond Money: Toward an Economy of Well- Being." *Psychological Science in the Public Interest*, 5(1): 1-31.
- DBD** **Diener, Ed and Robert Biswas-Diener.** 2000. "New Directions in Subjective Well-Being Research: The Cutting Edge." *Indian Journal of Clinical Psychology*, 27: 21-33.
- DLM** **Dolan, Paul, Richard Layard, and Robert Metcalfe.** 2011. "Measuring Subjective Wellbeing for Public Policy." Published by the Office for National Statistics in the UK.
- DG** **Doyal, Len, and Ian Gough.** 1992. "Need Satisfaction as a Measure of Human Welfare." In *Mixed Economies in Europe: An Evolutionary Perspective on their Emergence, Transition, and Regulation*. Ed. Wolfgang Blaas and John Foster.
- GHQ** **Goldberg, David and Paul Williams.** 1988. *A Users Guide to the General Health Questionnaire*. Windsor, UK: NFER-Nelson.
- G** **Graham, Carol.** 2011. *The Pursuit of Happiness: An Economy of Well-Being*. Washington, D.C.: Brookings Institution Press.
- GBF** **Grisez, Germain, Joseph Boyle, and John Finnis.** 1987. "Practical Principles, Moral Truth and Ultimate Ends." *American Journal of Jurisprudence*, 32: 99-151.
- KD** **Kahneman, Daniel, and Angus S. Deaton.** 2010. "High Income Improves Evaluation of Life but not Emotional Well-Being." *Proceedings of the National Academy of Sciences*, 107(38): 16489-16493.
- KSS** **Kapteyn, Arie, James P. Smith, and Arthur van Soest.** 2009. "Comparing Life Satisfaction." Rand Working Paper WR-623-1
- KN** **King, Laura A. and Christie K. Napa.** 1998. "What Makes a Life Good?" *Journal of Personality and Social Psychology*, 75(1): 156-165.
- KR** **Kraut, Richard.** 1979. "Two Conceptions of Happiness." *The Philosophical Review*, 88(2): 167-197.

- LU** **Loewenstein, George, and Peter A. Ubel.** 2008. "Hedonic Adaptation and the Role of Decision and Experience Utility in Public Policy." *Journal of Public Economics*, 92(8-9): 1795-1810.
- M(#)** **Maslow, Abraham.** 1946. "Theory of Human Motivation." In *Twentieth century psychology: recent developments in psychology*, By Philip Lawrence Harriman. (When it appears below, the # refers to the aspect's place in Maslow's hierarchy of needs, as follows: 1. Physiological; 2. Safety; 3. Love; 4. Esteem; and 5. Self-actualization.)
- MS** **Melo, Santiago.** 2011. "Eudaimonia and the Economics of Happiness." *Documentos CEDE*.
- SN** **Nussbaum, Martha.** 2011. *Creating Capabilities: The Human Development Approach*. Cambridge, MA: Harvard University Press.
- or
- Nussbaum, Martha.** 2000. *Women and Human Development: The Capabilities Approach*. Cambridge: Cambridge University Press.
- Q** **Qizilbash, Mozaffar.** 1996. "Capabilities, Well-Being and Human Development: A Survey." *The Journal of Development Studies*, 33(2), 143-162.
- or
- Qizilbash, Mozaffar.** 1996. "Ethical Development." *World Development*, 24(7): 1209-1221.
- RW** **Rawls, John.** 1971. *A Theory of Justice*. Cambridge, MA: Belknap Press of Harvard University Press.
- or
- Rawls, John.** 1982. "Social Unity and Primary Goods." In *Utilitarianism and Beyond*, edited by Amartya Sen and Bernard Williams, 159-186. New York: Cambridge University Press.
- R** **Ryff, Carol D.** 1989. "Happiness is Everything, or Is It? Explorations on the Meaning of Psychological Well-Being." *Journal of Personality and Social Psychology*, 57: 1069-1081.
- RS** **Ryff, Carol D. and Burton Singer.** 1998. "The Contours of Positive Human Health." *Psychological Inquiry*, 9(1): 1-28.

- ST** **Scitovsky, Tibor.** 1976. *The Joyless Economy: An Inquiry into Human Satisfaction and Consumer Dissatisfaction*. New York: Oxford University Press.
- SM** **Seligman, Martin E.P.** 2002. *Authentic Happiness: Using the New Positive Psychology to Realize Your Potential for Lasting Fulfillment*. New York: Free Press.
- SN** **Sen, Amartya.** 1985. *Commodities and Capabilities*. Oxford: Oxford University Press.
- SSF** **Stiglitz, Joseph E., Amartya Sen, and Jean-Paul Fitoussi.** 2009. *Report by the Commission on the Measurement of Economic Performance and Social Progress*. www.stiglitz-sen-fitoussi.fr
- SLW** **Sumner, L.W.** 1995. "The Subjectivity of Welfare." *Ethics*, 105(4): 764-790.
- TJ** **Tomer, John F.** 2010. "Enduring Happiness: Integrating the Hedonic and Eudaimonic Approaches." Available at SSRN: <http://ssrn.com/abstract=1708212>
- WA** **Waterman, Alan S.** 1993. "Two Conceptions of Happiness: Contrasts of Personal Expressiveness (Eudaimonia) and Hedonic Enjoyment." *Journal of Personality and Social Psychology*, 64(4): 678-691.
- WSC** **Waterman, Alan S., Seth J. Schwartz, and Regina Conti.** 2008. "The Implications of Two Conceptions of Happiness (Hedonic Enjoyment and Eudaimonia) for the Understanding of Intrinsic Motivation." *Journal of Happiness Studies*, 9: 41-79.
- PANAS** **Watson, David, Lee Anna Clark, and Auke Tellegen.** 1988. "Development and Validation of Brief Measures of Positive and Negative Affect: The PANAS Scales." *Journal of Personality and Social Psychology*, 54(6): 1063-1070.
- WD** **White, Matthew P. and Paul Dolan.** 2009. "Accounting for the Richness of Daily Activities." *Psychological Science*, 20(8): 1000-1008.

HRS This includes aspects that are inspired by the Psychosocial Leave-Behind from the Health and Retirement Study. These are distinct from usual SWB measures, since they tend to be more detailed than questions typically included on other large-scale surveys.

Aspect Class 4.

Int Our own introspection.

Aspect Class 5.

Sum New combination-aspect "summary measures.

Aspect Class 6.

Obj Subjective measures of "objective" indicators.

C.1.4 Our Master List of 136 Aspects:

1. how satisfied **you** are with your life (SWB, DS)
2. **your** rating of your life on a ladder where the lowest rung is "worst possible life for you" and the highest rung is "best possible life for you" (SWB, KD, DKS)
3. how close **your** life is to being ideal (MS, DE)
4. the overall well-being of **you** and your family (Sum, BHKS)
5. **you** feeling that things are going well for you (MS, DE)
6. **you** getting the things you want out of life (ABS, DE, SN)

7. the extent to which **you** feel the things you do in your life are worthwhile (DLM)
8. how fulfilling **your** life is (SN, SLW, KN, DE)
9. how rewarding the activities in **your** life are (WD, DLM)
10. **you** having a beautiful life story, or a life that is "like a work of art" (RS)
11. how full of beautiful memories **your** life is (Int, BHKS)
12. how grateful **you** feel for the things in your life (DE, SM)
13. how much **you** appreciate your life (SM, TJ)
14. the absence of regret **you** feel about your life (SM, HRS)
15. how desirable **your** life is (KR)
16. how glad **you** are to have the life you have rather than a different life (KN, ABS)
17. the extent to which **you** "have a good life" (SN, KN)
18. how much **you** like your life (Sum, BHKS)
19. **you** feeling that you have been fortunate in your life (Sum, BHKS)
20. **your** sense of optimism about your future (SM, DE-Flourishing)
21. **you** having many options and possibilities in your life and the freedom to choose among them (SN, DS, RW)
22. **your** sense that things are getting better and better (DBD)
23. how happy **you** feel (SWB, DS)
24. how much of the time **you** feel happy (SWB, DS, KD, DE)
25. how often **you** smile or laugh (G, SM, DS, KD, SWB)
26. how much **you** enjoy your life (DBD, AHC, Q, DS, KD, SWB)
27. the absence of sadness in **your** life (DE-SPANE, DS, KD, DKS)
28. **you** not feeling depressed (GHQ, ABS, R)
29. the absence of anger in **your** life (DKS, DE-SPANE, KD)
30. the absence of frustration in **your** life (WD, DS)

31. the absence of fear in **your** life (SN, PANAS, DE-SPANE, DS)
32. **you** not feeling anxious (DLM, WD)
33. the absence of stress in **your** life (DKS, GHQ, DLM, DE, KD, DS)
34. the absence of worry in **your** life (DLM, GHQ, KD, DKS)
35. the quality of **your** sleep (DKS)
36. **your** physical safety and security (GBF, CR, G, Q, DG, M2, SN, SSF)
37. the amount of order and stability in **your** life (Int, BHKS)
38. **your** sense of security about life and the future in general (Int, BHKS)
39. **your** physical comfort (M1)
40. **your** freedom from pain (DG, BHKR, SN, DKS)
41. how easy and free of annoyances **your** life is (HRS)
42. how peaceful, calm, and harmonious **your** life is (TJ, GBF)
43. how often **you** can feel relaxed instead of feeling your life is hectic (DLM, WD, WSC)
44. **you** feeling that you have enough time and money for the things that are most important to you (BHKS)
45. **your** financial security (DBD, DLM, G, DG)
46. **your** material standard of living (DE, WSC, SSF)
47. **your** ability to dream and pursue your dreams (LU)
48. **your** ability to use your imagination and be creative (SN, AHC, KN, RW)
49. **you** having many moments in your life when you feel inspired (SM, PANAS)
50. how much beauty **you** experience in your life (WA, SM, RW)
51. the amount of pleasure in **your** life (WD, BBM, DE, DS)
52. the amount of fun and play in **your** life (SN, BHKR, GBF)
53. **you** having new things, adventure, and excitement in your life (ST)
54. **your** sense of discovery and wonder (SM, M(desire))

55. **you** feeling that you understand the world and the things going on around you (DG, BMP, M(desire))
56. **your** knowledge, skills, and access to information (GBF, SM, SN, SSF, RW)
57. how often **you** are able to challenge your mind in a productive or enjoyable way (WA, DE)
58. how interesting, fascinating, and free of boredom **your** life is (DE, ABS, PANAS, BHKR, DS)
59. **your** ability to be yourself and express yourself (WA, BMP, LU, M5)
60. **your** personal growth (R, BMP)
61. **you** "being the person you want to be" (SN, BHKS)
62. **your** ability to fulfill your potential (TJ, WSC, R, M5)
63. **your** sense of purpose (R, DE-Flourishing, KN, TJ, BHKR, DS)
64. **you** feeling that your life has direction (RS, AHC, RW)
65. **your** sense of control over your life (SN, G, BHKR, R)
66. **your** sense that your life is meaningful and has value (G, LU,R, SM, KN, GBF, TJ, DE-Flourishing, DS, M(desire))
67. **your** sense that you are making a difference, actively contributing to the well-being of other people, and making the world a better place (DS, DE-Flourishing, BBM, LU, DLM)
68. the overall quality of **your** experience at work (DS, KSS, DG, DE, SM, DLM, SN, SSF)
69. how often **you** become deeply engaged in your daily activities (so deeply engaged that you lose track of time) (DE-Flourishing, DS, WSC)
70. **your** feeling of independence and self-sufficiency (SN, R, DCG, M4, MS)
71. **your** sense that you are competent and capable in the activities that matter to you (DE-Flourishing, WA)
72. **your** ability to shape and influence the things around you (DCG, R)
73. **your** sense of achievement and excellence (MS, SN, KN, RS, DS)

74. **your** enjoyment of winning, competing, and facing challenges (WA)
75. **your** success at accomplishing your goals (SLW, DE, DS)
76. **your** chance to live a long life (SN, AHC, SSF)
77. **your** health (SM, G, RS, Q, DS, SN, SSF, RW)
78. **your** mental health and emotional stability (DG, SN, AHC, GHQ, DS, DLM, TJ)
79. **your** absence of internal conflict (conflict within yourself) (RS, BMP)
80. **your** ability to fully experience the entire range of healthy human emotions (LU, SN)
81. **you** feeling alive and full of energy (DLM, WA, DG, PANAS, RW)
82. **your** passion and enthusiasm about things in your life (PANAS, SM)
83. **your** pride and respect for yourself (PANAS, ABS, SN, DE, RW)
84. **you** having the people around you think well of you and treat you with dignity and respect (AHC, SN, M4, DE-Flourishing, RW)
85. **you** having a role to play in society (TJ, AHC, DG, DBD, SN)
86. how much love there is in **your** life (SN, KN, RS, SM)
87. the quality of **your** romantic relationships, marriage, love life or sex life (SM, SN, AHC, KSS, DS, M3, R)
88. **your** ability to have and raise children (AHC, DCG, KSS, SN)
89. the quality of **your** family relationships (TJ, AHC, DS, M3, R, SSF)
90. the happiness of **your** family (BHKR, LU)
91. **your** sense of community, belonging, and connection with other people (SN, DS, LU, DE-Flourishing)
92. **you** having people around you who share your values, beliefs and interests (HRS)
93. **you** having people you can turn to in time of need (DE-Flourishing, HRS)
94. **you** not being lonely (ABS, DS, SM)

95. **you** feeling that you are understood (BHKS)
96. **your** opportunities to participate in ceremonies, cultural events, and celebrations that are meaningful to you (BHKS)
97. **your** freedom from being lied to, deceived, or betrayed (M(desire), HRS)
98. **your** freedom from emotional abuse or harassment (BHKS)
99. the absence of humiliation and embarrassment in **your** life (SN)
100. the absence of shame and guilt in **your** life (PANAS, DCG, SN)
101. **your** sense that everything happens for a reason (BHKS)
102. **your** sense of connection with the universe or the power behind the universe (TJ)
103. **you** being a good, moral person and living according to your personal values (DBD, DE-Flourishing, MS, RS, TJ)
104. **you** feeling that you are part of something bigger than yourself (SM, TJ)
105. **your** sense that you are standing up for what you believe in (BHKS)
106. **your** sense that you know what to do when you face choices in your life (BHKS)
107. **your** ability to "be in the moment" (HRS)
108. **your** ability to keep good perspective in your life (BHKS)
109. how high **your** income is compared to the income of other people around you (DS, TJ)
110. **your** power over other people (BHKS)
111. **your** social status (DCG, TJ, BHKR, M)
112. **you** having others remember you and your accomplishments long after your death (BD)
113. the happiness of **your** friends (MS, BHKR, LU)
114. the condition of animals, nature, and the environment in the **world** (SN, SSF, AHC)

115. the amount of love in the **world** (BHKS)
116. the well-being of the people in the **world** (LU, RS)
117. the extent to which **humanity** does things worthy of pride (BHKS)
118. the morality, ethics, and goodness of other people in your **nation** (BHKS)
119. the well-being of the people in your **nation** (LU, RS)
120. your **nation** being a just society (MS, SN, GBF)
121. the extent to which your **nation** does things worthy of pride (BHKS, BD)
122. the amount of freedom in **society** (G)
123. freedom of speech and **people's** ability to take part in the political process and community life (SN, SSF, Q, DG, AHC, RW)
124. freedom of conscience and belief in your **nation** (SN, Q, RW)
125. equality of income in your **nation** (BC)
126. equality of opportunity in your **nation** (SN, Q, G, RW)
127. **society** helping the poor and others who struggle (BHKS)
128. **people** getting the rewards and punishments they deserve (BBM)
129. the amount of order and stability in **society** (BHKS, BD)
130. freedom from corruption, injustice, and abuse of power in your **nation** (G)
131. trust among the people in your **nation** (DS, R)
132. the total size of your **nation's** economy (GDP) (Obj)
133. the average income of people in your **nation** (GDP per capita) (Obj)
134. the rate of economic growth (GDP growth) over time in your **nation** (Obj)
135. how low the rate of unemployment is in your **nation** (Obj)
136. how low the rate of inflation is in your **nation's** economy (Obj)

C.1.5 Aspects of Well-Being by Whom They Refer To

We distinguish between five types of aspects according to who is described as affected by the level of that aspect.

1. **You-aspects** are aspects of well-being that pertain to one's own well-being (e.g. "how satisfied you are with your life") as well as the well-being of those who are emotionally close (such as one's family), without reference to others outside one's close circle. These aspects may be affected by the personal decisions of individuals without affecting the entire society. Hence, they can differ between individuals living in the same society (e.g., while one is satisfied with one's life, others in one's nation could be dissatisfied with their lives), but they could also in principle increase or decrease for everyone simultaneously. We view aspects 1-108 in the master list in C.1.4 above as *you*-aspects.
2. **You-only aspects** are similar to *you*-aspects, but they are inherently relative to others (e.g., "your social status"). Hence, while they may be affected by personal decisions, they also affect others due to the externalities (positive or negative) they necessarily inflict on others, and they cannot meaningfully increase or decrease for everyone simultaneously. We view aspects 109-113 in the master list in C.1.4 above as *you-only*-aspects. We view the first four—relative income, power over other people, social status, and post-mortem fame—as mostly comparative, zero-sum aspects, which could not in themselves vary for the nation as a whole, except for their dimensions that are already mostly captured by other aspects. For example, we felt that the *you*-aspects 84 and 85—having the people around you think well of you and treat you with dignity and respect, and having a role to play in society—capture important dimensions of the non-zero-sum part of the idea of social status. As to the fifth *you-only*-aspect—the happiness of your friends—we view it as a positive externality that does not meaningfully add up in the context of our scenarios: increasing or decreasing everyone's friends' happiness is reasonably simplified as increasing or de-

creasing everyone's happiness.

3. **Public-aspects** are essentially "public good" aspects: they pertain to an entire society's well-being, such as the entire nation (e.g., "equality of opportunity in your nation"), or, when stated, the entire world (e.g., "the condition of animals, nature, and the environment in the world"). In contrast with *you*- and *you-only*-aspects, *public*-aspects cannot typically be affected by the personal decisions of individuals, but they may be affected through national policy. Moreover, *public*-aspects cannot differ between individuals living in the same society; their levels are the same for everyone, and they can only increase or decrease for everyone simultaneously. We view aspects 114-136 in the master list in C.1.4 above as *public*-aspects.
4. **Everyone-aspects** are *you*-aspects applied simultaneously to all individuals in the nation. For example, the *you*-aspect "how satisfied you are with your life" is modified to become the *everyone*-aspect "how satisfied people are with their lives"; the legend in the SP survey instructions explains that by the word "people" we refer to everyone in the nation (see 3.3.2 in the main text, or C.2 below). Like *public*-aspects, *everyone*-aspects can be affected through policy and cannot typically be affected by the personal decisions of individuals; and like *public*-aspects, by construction they cannot differ between individuals in the same nation and can only increase or decrease for everyone simultaneously. The list of 108 everyone-aspects—a modified version of the 108 *you*-aspects from the list in C.1.4 above—is provided in subsection C.1.6 below.
5. **Others-aspects** are similar to *everyone*-aspects with one exception: as explained in the SP-survey instructions legend, the word "others" refers to others in the nation, excluding the respondent and the respondent's emotionally-close circle. In other words, *others*-aspects are *you*-aspects applied simultaneously to all individuals in the nation excluding the respondent's close circle. Hence, for example, the *you*-aspect "how satisfied you are with your life" becomes the *others*-aspect "how satisfied others are with their lives"; in principle, a *you*-aspect and the corresponding *others*-aspect

together add up to the corresponding *everyone*-aspect: how satisfied you and others are with your lives = how satisfied everyone is with their lives. By including both *you*- and *others*-aspects in the same scenario, we could explore how respondents trade off, e.g., their life satisfaction with the life satisfaction of unfamiliar others in the nation. As noted, such scenarios are not analyzed in the present paper. For completeness, however, the list of 108 *others*-aspects—a modified version of the 108 *you*-aspects from the list in C.1.4 above—is provided in subsection C.1.7 below.

A note about everyone- and others-aspects. One might care about aspects of others' lives for altruistic, ideological, or other reasons. We consider any ethical duty people feel to speak up for those who are unable to speak up for themselves, however, to be separate from the preferences regarding what is happening to other people. In our survey, we told people to assume that other people also had a vote on policy in an attempt to relieve them from any ethical need to speak up for those who cannot speak for themselves and thereby isolate the preferences about what is happening to others from the fairness notion that everyone should have a voice.

C.1.6 Aspects 1-108 Modified to Apply to Everyone (*everyone*-aspects)

1. how satisfied **people** are with their lives
2. **people's** ratings of their lives on a ladder where the lowest rung is "worst possible life for them" and the highest rung is "best possible life for them"
3. how close **people's** lives are to being ideal
4. the overall well-being of **people** and their families
5. **people** feeling that things are going well for them
6. **people** getting the things they want out of life

7. the extent to which **people** feel the things they do in their lives are worthwhile
8. how fulfilling **people's** lives are
9. how rewarding the activities in **people's** lives are
10. **people** having a beautiful life story, or a life that is "like a work of art"
11. how full of beautiful memories **people's** lives are
12. how grateful **people** feel for the things in their lives
13. how much **people** appreciate their lives
14. the absence of regret **people** feel about their lives
15. how desirable **people's** lives are
16. how glad **people** are to have the lives they have rather than different lives
17. the extent to which **people** "have a good life"
18. how much **people** like their lives
19. **people** feeling that they have been fortunate in their lives
20. **people's** sense of optimism about their future
21. **people** having many options and possibilities in their lives and the freedom to choose among them
22. **people's** sense that things are getting better and better
23. how happy **people** feel
24. how much of the time **people** feel happy
25. how often **people** smile or laugh
26. how much **people** enjoy their lives
27. the absence of sadness in **people's** lives
28. **people** not feeling depressed
29. the absence of anger in **people's** lives
30. the absence of frustration in **people's** lives

31. the absence of fear in **people's** lives
32. **people** not feeling anxious
33. the absence of stress in **people's** lives
34. the absence of worry in **people's** lives
35. the quality of **people's** sleep
36. **people's** physical safety and security
37. the amount of order and stability in **people's** lives
38. **people's** sense of security about life and the future in general
39. **people's** physical comfort
40. **people's** freedom from pain
41. how easy and free of annoyances **people's** lives are
42. how peaceful, calm, and harmonious **people's** lives are
43. how often **people** can feel relaxed instead of feeling their lives are hectic
44. **people** feeling that they have enough time and money for the things that are most important to them
45. **people's** financial security
46. **people's** material standard of living
47. **people's** ability to dream and pursue their dreams
48. **people's** ability to use their imaginations and be creative
49. **people** having many moments in their lives when they feel inspired
50. how much beauty **people** experience in their lives
51. the amount of pleasure in **people's** lives
52. the amount of fun and play in **people's** lives
53. **people** having new things, adventure, and excitement in their lives
54. **people's** sense of discovery and wonder
55. **people** feeling that they understand the world and the things going on around them

56. **people's** knowledge, skills, and access to information
57. how often **people** are able to challenge their minds in a productive or enjoyable way
58. how interesting, fascinating, and free of boredom **people's** lives are
59. **people's** ability to be themselves and express themselves
60. **people's** personal growth
61. **people** "being the people they want to be"
62. **people's** ability to fulfill their potential
63. **people's** sense of purpose
64. **people** feeling that their lives have direction
65. **people's** sense of control over their lives
66. **people's** sense that their lives are meaningful and have value
67. **people's** sense that they are making a difference, actively contributing to the well-being of other people, and making the world a better place
68. the overall quality of **people's** experience at work
69. how often **people** become deeply engaged in their daily activities (so deeply engaged that they lose track of time)
70. **people's** feeling of independence and self-sufficiency
71. **people's** sense that they are competent and capable in the activities that matter to them
72. **people's** ability to shape and influence the things around them
73. **people's** sense of achievement and excellence
74. **people's** enjoyment of winning, competing, and facing challenges
75. **people's** success at accomplishing their goals
76. **people's** chances to live long lives
77. **people's** health
78. **people's** mental health and emotional stability

79. **people's** absence of internal conflict (conflict within a person)
80. **people's** ability to fully experience the entire range of healthy human emotions
81. **people** feeling alive and full of energy
82. **people's** passion and enthusiasm about things in their lives
83. **people's** pride and respect for themselves
84. **people** having the people around them think well of them and treat them with dignity and respect
85. **people** having a role to play in society
86. how much love there is in **people's** lives
87. the quality of **people's** romantic relationships, marriage, love life or sex life
88. **people's** ability to have and raise children
89. the quality of **people's** family relationships
90. the happiness of **people's** families
91. **people's** sense of community, belonging, and connection with other people
92. **people** having people around them who share their values, beliefs and interests
93. **people** having people they can turn to in time of need
94. **people** not being lonely
95. **people** feeling that they are understood
96. **people's** opportunities to participate in ceremonies, cultural events, and celebrations that are meaningful to them
97. **people's** freedom from being lied to, deceived, or betrayed
98. **people's** freedom from emotional abuse or harassment
99. the absence of humiliation and embarrassment in **people's** lives

100. the absence of shame and guilt in **people's** lives
101. **people's** sense that everything happens for a reason
102. **people's** sense of connection with the universe or the power behind the universe
103. **people** being good, moral people and living according to their personal values
104. **people** feeling that they are part of something bigger than themselves
105. **people's** sense that they are standing up for what they believe in
106. **people's** sense that they know what to do when they face choices in their lives
107. **people's** ability to "be in the moment"
108. **people's** ability to keep good perspective in their lives

C.1.7 Aspects 1-108 Modified to Apply to Others (*others-aspects*)

1. how satisfied **others** are with their lives
2. **others'** ratings of their lives on a ladder where the lowest rung is "worst possible life for them" and the highest rung is "best possible life for them"
3. how close **others'** lives are to being ideal
4. the overall well-being of **others** and their families
5. **others** feeling that things are going well for them
6. **others** getting the things they want out of life
7. the extent to which **others** feel the things they do in their lives are worthwhile
8. how fulfilling **others'** lives are
9. how rewarding the activities in **others'** lives are

10. **others** having a beautiful life story, or a life that is "like a work of art"
11. how full of beautiful memories **others'** lives are
12. how grateful **others** feel for the things in their lives
13. how much **others** appreciate their lives
14. the absence of regret **others** feel about their lives
15. how desirable **others'** lives are
16. how glad **others** are to have the lives they have rather than different lives
17. the extent to which **others** "have a good life"
18. how much **others** like their lives
19. **others** feeling that they have been fortunate in their lives
20. **others'** sense of optimism about their future
21. **others** having many options and possibilities in their lives and the freedom to choose among them
22. **others'** sense that things are getting better and better
23. how happy **others** feel
24. how much of the time **others** feel happy
25. how often **others** smile or laugh
26. how much **others** enjoy their lives
27. the absence of sadness in **others'** lives
28. **others** not feeling depressed
29. the absence of anger in **others'** lives
30. the absence of frustration in **others'** lives
31. the absence of fear in **others'** lives
32. **others** not feeling anxious
33. the absence of stress in **others'** lives
34. the absence of worry in **others'** lives

35. the quality of **others'** sleep
36. **others'** physical safety and security
37. the amount of order and stability in **others'** lives
38. **others'** sense of security about life and the future in general
39. **others'** physical comfort
40. **others'** freedom from pain
41. how easy and free of annoyances **others'** lives are
42. how peaceful, calm, and harmonious **others'** lives are
43. how often **others** can feel relaxed instead of feeling their lives are hectic
44. **others** feeling that they have enough time and money for the things that are most important to them
45. **others'** financial security
46. **others'** material standard of living
47. **others'** ability to dream and pursue their dreams
48. **others'** ability to use their imaginations and be creative
49. **others** having many moments in their lives when they feel inspired
50. how much beauty **others** experience in their lives
51. the amount of pleasure in **others'** lives
52. the amount of fun and play in **others'** lives
53. **others** having new things, adventure, and excitement in their lives
54. **others'** sense of discovery and wonder
55. **others** feeling that they understand the world and the things going on around them
56. **others'** knowledge, skills, and access to information
57. how often **others** are able to challenge their minds in a productive or enjoyable way
58. how interesting, fascinating, and free of boredom **others'** lives are

59. **others'** ability to be themselves and express themselves
60. **others'** personal growth
61. **others** "being the people they want to be"
62. **others'** ability to fulfill their potential
63. **others'** sense of purpose
64. **others** feeling that their lives have direction
65. **others'** sense of control over their lives
66. **others'** sense that their lives are meaningful and have value
67. **others'** sense that they are making a difference, actively contributing to the well-being of other people, and making the world a better place
68. the overall quality of **others'** experience at work
69. how often **others** become deeply engaged in their daily activities (so deeply engaged that they lose track of time)
70. **others'** feeling of independence and self-sufficiency
71. **others'** sense that they are competent and capable in the activities that matter to them
72. **others'** ability to shape and influence the things around them
73. **others'** sense of achievement and excellence
74. **others'** enjoyment of winning, competing, and facing challenges
75. **others'** success at accomplishing their goals
76. **others'** chances to live long lives
77. **others'** health
78. **others'** mental health and emotional stability
79. **others'** absence of internal conflict (conflict within a person)
80. **others'** ability to fully experience the entire range of healthy human emotions
81. **others** feeling alive and full of energy

82. **others'** passion and enthusiasm about things in their lives
83. **others'** pride and respect for themselves
84. **others** having the people around them think well of them and treat them with dignity and respect
85. **others** having a role to play in society
86. how much love there is in **others'** lives
87. the quality of **others'** romantic relationships, marriage, love life or sex life
88. **others'** ability to have and raise children
89. the quality of **others'** family relationships
90. the happiness of **others'** families
91. **others'** sense of community, belonging, and connection with other people
92. **others** having people around them who share their values, beliefs and interests
93. **others** having people they can turn to in time of need
94. **others** not being lonely
95. **others** feeling that they are understood
96. **others'** opportunities to participate in ceremonies, cultural events, and celebrations that are meaningful to them
97. **others'** freedom from being lied to, deceived, or betrayed
98. **others'** freedom from emotional abuse or harassment
99. the absence of humiliation and embarrassment in **others'** lives
100. the absence of shame and guilt in **others'** lives
101. **others'** sense that everything happens for a reason
102. **others'** sense of connection with the universe or the power behind the universe
103. **others** being good, moral people and living according to their personal values

- 104. **others** feeling that they are part of something bigger than themselves
- 105. **others'** sense that they are standing up for what they believe in
- 106. **others'** sense that they know what to do when they face choices in their lives
- 107. **others'** ability to "be in the moment"
- 108. **others'** ability to keep good perspective in their lives

C.2 Instructions Screen

On the following screens we will present you with a series of questions.

In each question, we will ask you to make a choice between two options. While some of the choices will relate to personal decisions that you face, others will relate to national policy questions that you and everyone else in your nation vote on.

The only information we will give you about the two options will be presented in a table similar to the example table below. The table compares the two options in terms of a few of their possible consequences over the next four years. For each possible consequence, the table indicates whether one option will rank higher than the other, and by how much.

Example table (related to a policy question):

	OPTION 1			about equal	OPTION 2		
	much higher	somewhat higher	slightly higher		slightly higher	somewhat higher	much higher
your health			X				
others not feeling anxious						X	
how satisfied people are with their lives		X					
the amount of freedom in society					X		
...	(This is an example table. The actual table will have between two and six rows.)						

After showing you the table, we will ask you:

Between these two options, which do you think you would choose?

Please try to carefully study each table on the following screens, and answer every question the best you can.

(The items and their rankings in the tables are randomly chosen by the computer so that we learn as much as possible from your choices. We learn the most if you pay careful attention to all the items and their rankings when choosing.)

IMPORTANT: Notice that in each row of the table above, one word is emphasized in boldface type (e.g.: **your**, **others**, **people**, **society**). Please pay careful attention to the emphasized words, and interpret a consequence with the following emphasized words as affecting the following people:

you/your: affects only you (and, when stated, your family or close friends).

others/others*: does not affect you, your family, or your friends—but does affect other people. The table indicates the average effect on other people in your nation.

nation/society/people: affects everyone in your nation (including you, your family, and your friends).

world/humanity: affects everyone in the world.

Aside from the differences indicated in the table, please assume that the two options rank *about equal* to each other in terms of **any possible consequences that are not mentioned in the table**. In other words, the two options are predicted to differ **only** on the things that are listed. For example, while the example table above indicates that Option 1 ranks slightly higher than Option 2 in terms of **your** health, you should assume that **others'** health is on average *about equal* across the two options.

When you are ready to start the survey, click "Next".

C.3 Demographics from the Census

Table C.2: Detailed Citation for the Census Information in Table 3.1

Variable	Detail
Marital Status	Table S1201: Marital Status, 2010 American Community Survey 1-Year Estimates. Calculated for the U.S. population 20 years and older. "Other" includes widowed, divorced, and separated.
Highest Education Level Completed	Table S1501: Educational Attainment, 2010 American Community Survey 1-Year Estimates. Calculated for the U.S. population 25 years and older.
Age	Table QT-P1: Age Groups and Sex: 2010, 2010 Census Summary File 1
Income	Table HINC-06. Income Distribution to \$250,000 or More for Households: 2010, Current Population Survey, 2011 Annual Social and Economic Supplement
Region	Table GCT-P2: Age Groups and Sex: 2010 - United States— Region, Division, and States; and Puerto Rico, 2010 Census Summary File 1. Calculated for population 18 years and older.
Race	Table QT-PL: Race, Hispanic or Latino, Age, and Housing Occupancy: 2010, 2010 Census National Summary File of Redistricting Data. Calculated for the U.S. population 18 years and older.
Household Size	Table QT-H2: Tenure, Household Size, and Age of Householder: 2010, 2010 Census Summary File 1
Employment Status	Table CP03: Selected Economic Characteristics, 2010 American Community Survey 1-Year Estimates. Calculated for the U.S. population 16 years and older.

C.4 Detecting Overlap in Survey Questions

Here we extend our theoretical framework to accommodate the possibility that individual survey questions may encompass more than one fundamental aspect, and survey questions might therefore overlap in content. Using this framework, we sketch an extension of our SP survey that could be used to test whether there is overlap between a given pair of survey questions. We emphasize that the purpose of this appendix is not to provide a complete analysis of overlap—an endeavor to which an entire paper could be devoted—but rather to demonstrate that methods based on stated preferences for detecting overlap can be developed, and to take some initial steps toward developing such methods. We note that it may be possible to prioritize which pairs of questions to test for overlap on the basis of researchers’ intuitions or respondents’ answers to direct probes asking about conceptual overlap. Our focus here, however, is on the test itself rather than on the prioritization process.

As mentioned in section 3.6.1 of the main text, the overlap-detection method we propose proceeds in three steps. First, a set of SP-survey scenarios offers choices between a fixed, small increase in the first aspect in the pair being tested—say, life satisfaction—and various amounts of a small increase in a third aspect that serves as a numeraire. The amount of increase in the numeraire that makes the respondent indifferent is a measure of the utility gain from the increase in life satisfaction. Second, another set of SP-survey scenarios offers choices between a fixed, small increase in the second aspect in the pair—say, life worthwhileness—and various amounts of a small increase in the numeraire. The estimated numeraire indifference amount measures the utility gain from the increase in life worthwhileness. Third, a final set of SP-survey scenarios offers choices where one option is both the fixed increase in life satisfaction and the fixed increase in life worthwhileness, and the other option is various amounts of a small increase in the numeraire. These scenarios yield an estimate of the utility gain from the joint increase. We then compare the utility gain from the joint increase to the sum of the utility gains from the separate increases. Intu-

itively, if life satisfaction and life worthwhileness capture nonoverlapping arguments of preferences, then since any smooth utility function is locally linear, the utility gain from the small joint increase in both arguments will be equal to the sum of utility gains from the small separate increases in each. In contrast, if the two questions assess overlapping arguments of preferences, then the utility gain from a small joint increase will be less than the sum of utility gains from the small separate increases because the overlapping part of the joint increase is taken into account by the survey respondent only once.

While this intuition may seem straightforward, it is less trivial than it appears. The subtlety is that a respondent could have different interpretations of what happens to the underlying fundamental aspects of well-being when told that two SWB questions separately increase than when told that they jointly increase.

This appendix develops a theoretical framework for analyzing respondents' interpretations of SP-survey scenarios, and proposes two distinct sets of constraints on respondents' interpretations under which this overlap-detection method is valid. Importantly, we note that some of these constraints can be made more likely to hold in practice by appropriately formulating the SP-survey instructions to encourage respondents to interpret the scenarios in accordance with the constraints. We emphasize, however, that while we believe that the constraints we propose are reasonable ones, we would advocate further analysis and, as much as possible, empirical testing of the assumptions underlying these constraints before the overlap-detection method we describe is used in practice.

The remainder of this appendix is organized as follows. Subsection C.4.1 illustrates the overlap-detection method in the context of a specific example. Subsection C.4.2 formally introduces the theoretical framework. Subsections C.4.3 and C.4.4 define the two different sets of constraints and demonstrate that, given either set of constraints, the overlap-detection method is justified. Proofs are relegated to subsection C.4.5.

C.4.1 Illustrative Example

The government wants to test whether conceptually-overlapping information is contained in an individual's responses to a proposed list of $N = 5$ SWB-survey questions:

- (r_1) In general, how would you say your health is?
- (r_2) Overall, how happy did you feel yesterday?
- (r_3) Overall, how anxious did you feel yesterday? [reverse-coded so that higher responses mean less anxiety]
- (r_4) Overall, how satisfied are you with your life nowadays?
- (r_5) Overall, to what extent do you feel the things you do in your life are worthwhile?

(Question 1 is a standard self-reported overall health measure; this particular one is taken from the AGES-Reykjavik Study. Questions 2-5 are the four U.K. questions listed in the Introduction of the main text, here reordered.) While in reality the SWB survey would likely elicit each response r_n on a discrete scale (e.g., a number from 1-100 scale), for the purpose of the theory, we assume that the r_n 's are real numbers.

We distinguish between the responses to SWB survey questions (the r_n 's) and the respondent's levels of the fundamental aspects (the w_j 's) that the questions are intended to measure. To accommodate the possibility of overlap in the r_n 's, we need to generalize the theory from the main text by allowing the r_n 's to be functions of more than one fundamental aspect. In this example, suppose that there are $J = 3$ fundamental aspects—i.e., preferences are defined over three fundamental goods:

- (w_1) health
- (w_2) happiness
- (w_3) lack of anxiety.

Each response to a SWB question is a function of the respondent's fundamental-aspect levels. We call this relationship the response's "production function." To illustrate, assume the following production functions:

$$r_1 = f_1(w_1) = w_1 \quad (\text{C.1})$$

$$r_2 = f_2(w_2) = w_2 \quad (\text{C.2})$$

$$r_3 = f_3(w_3) = w_3 \quad (\text{C.3})$$

$$r_4 = f_4(w_1, w_2) = \frac{1}{2}w_1 + \frac{1}{2}w_2 \quad (\text{C.4})$$

$$r_5 = f_5(w_2, w_3) = \frac{1}{2}w_2 + \frac{1}{2}w_3 \quad (\text{C.5})$$

In this example, the production function f_2 means that the response r_2 elicited by the question "Overall, how happy did you feel yesterday?" is equal to the respondent's current level of happiness, w_2 . The production function f_4 means that the response r_4 (to the life satisfaction question), is equal to the average of the respondent's levels of w_1 (health) and w_2 (happiness). In this subsection, the production functions are assumed to be linear. In the more general formulation in subsequent subsections, the functions will be assumed to be smooth and hence can be approximated as linear for small changes in the w_j 's around current levels, $(\bar{w}_1, \bar{w}_2, \bar{w}_3)$. This linearity means that possible complementarities in the f_n 's can be ignored in the analysis.

Since r_1 , r_2 , and r_3 each elicit exactly one fundamental aspect, we call them "fundamental responses," while r_4 and r_5 are "combination responses." Two responses "overlap" if their production functions depend on the same fundamental aspect. For example, r_4 and r_5 overlap because f_4 and f_5 both depend on w_2 . (For the same reason, they both also overlap with r_2 .) The researcher observes the responses, but not the fundamental-aspect levels. Furthermore, the production functions are unknown to the researcher; if they were known, it would be straightforward to identify pairs of SWB questions whose responses overlap,

and an overlap-detection method would not be needed.

The respondent's preferences depend on the levels of the fundamental aspects. For the example, we assume preferences can be represented by the utility function

$$u(w_1, w_2, w_3) = w_1 + w_2 + w_3. \quad (\text{C.6})$$

Once again, in the more general formulation that follows, preferences will be assumed to be smooth, and linearity will be justified as an approximation that holds when the changes in the w_j 's are small. The linear utility function means that possible complementarities in preferences can be ignored in the analysis.

Consider our method for detecting overlap, and the corresponding design of the SP survey, in the simplest case: testing for overlap between two responses that happen to be fundamental, r_2 and r_3 , and hence in fact do not overlap. In the first of the method's three steps, a set of SP-survey scenarios asks the respondent to choose between a 1-unit gain in "happiness yesterday" (r_2) and varying amounts of a gain in a survey question that serves as a numeraire, say health (r_1). (In this example, the numeraire is a fundamental response (r_1), but we will show more generally that any response could be chosen as the numeraire.) This set of scenarios assesses the amount of gain in r_1 that would make the respondent indifferent to the 1-unit gain in r_2 . Given the utility function in equation C.6, this amount is 1 unit, and thus we will find that the relative marginal utility of r_2 is 1. The second step analogously assesses the relative marginal utility of r_3 with a set of scenarios where Option 1 is always a 1-unit gain in lack-of-anxiety (r_3), and Option 2 is varying amounts of a gain in r_1 . This relative marginal utility is also 1. In the third step, Option 1 is a 1-unit gain in r_2 and a 1-unit gain in r_3 , and as usual Option 2 is varying amounts of a gain in r_1 . The relative marginal utility of this joint increase is 2, which equals the sum of the relative marginal utilities of the separate increases.

The potential difficulties mentioned above arise when dealing with combination responses. The basic problem is that when one of the options in a SP survey specifies a given change in a combination response, there are many possible

changes in the underlying fundamental aspects that could correspond to that specified change in the combination response. To analyze which of the possible fundamental-aspect changes is actually conceived by the respondent, we will define "interpretation functions." They characterize the changes in fundamental aspects that a respondent envisions as a function of the changes in responses specified in the SP-survey option. These interpretation functions are unknown to the researcher.

To illustrate, consider testing for overlap between two combination responses that overlap, r_4 and r_5 . The first set of SP-survey scenarios asks the respondent to choose between a 1-unit gain in the response to the life satisfaction question (r_4) and varying amounts of a gain in the numeraire, health (r_1). Suppose the respondent interprets a 1-unit gain in life satisfaction as meaning that there is a 1-unit gain in each of its constituents, health (w_1) and happiness (w_2). Then we will find that the respondent is indifferent between a 1-unit gain in r_4 and a 2-unit gain in r_1 . The second set of SP-survey scenarios asks the respondent to choose between a 1-unit gain in the response to the life worthwhileness question (r_5) and varying amounts of a gain in health (r_1). Supposing the respondent interprets a 1-unit gain in life worthwhileness as meaning that there is a 1-unit gain in each of its constituents—happiness (w_2) and lack of anxiety (w_3)—then we will again find that the relative marginal utility is 2. In the third step, Option 1 is a 1-unit gain in r_4 and a 1-unit gain in r_5 , and as usual Option 2 is varying amounts of a gain in r_1 . Suppose that the respondent interprets Option 1 as meaning that there is a 1-unit gain in each of health (w_1), happiness (w_2), and lack of anxiety (w_3). While not the only possible interpretation, it may seem natural: it is consistent with r_4 and r_5 each having increased by 1 unit, and it matches the interpretation of what happens to w_2 under either of the separate increases in r_4 and r_5 . Given that interpretation, the relative marginal utility of the joint increase is 3, which is indeed less than the sum of the relative marginal utilities of the separate increases.

Of course, this example made specific assumptions about how the respondent interprets the changes in the combination responses. In the remainder of

this appendix, we will provide a more general framework for analyzing SP-survey responses. Rather than assuming particular interpretations, we show that our proposed overlap-detection method works under a wide range of possible interpretation functions, as long as they satisfy certain plausible constraints. There are interpretation functions satisfying each of the two sets of constraints that we will analyze that in fact will generate the interpretations that we simply assumed in the above example.

C.4.2 Theoretical Framework

We assume that a respondent's preferences can be represented by a continuously-differentiable utility function, $u(w_1, \dots, w_J)$, that is a monotonically increasing function of each of J fundamental aspects. Without loss of generality, here we orient the w_j 's so that higher levels are more preferred (e.g., "lack of anxiety" rather than "anxiety" is the fundamental aspect).

While the government cannot directly elicit the w_j 's, the government can elicit responses to a set of N SWB-survey questions, r_1, \dots, r_N . Each such response r_n is a continuously-differentiable and strictly increasing function f_n of a subset of the fundamental aspects. We call f_n the **production function** for response r_n . Abusing notation, we write " $w_j \in r_n$ " to signify that w_j is an argument of f_n .

We suppose that the SWB survey elicits the respondent's level of each r_n on a quantitative scale (e.g., points on a 1-100 scale), and the SP survey asks the respondent about quantitative changes on the same scale (unlike the simplified SP survey that we used in the main text). If some f_n is a function of just a single fundamental aspect w_j , then the response r_n corresponds one to one with w_j ; any such r_n can thus be used as a measure of w_j on both the SWB and SP surveys. We call such a r_n a **fundamental response**. We call any r_n whose corresponding f_n depends on more than one fundamental aspect a **combination response**. The government does not observe which, or even how many, fundamental aspects each r_n depends on.

We say that r_n and $r_{n'}$ overlap if f_n and $f_{n'}$ share at least one fundamental aspect as an argument. We say that r_n and $r_{n'}$ locally overlap if there is some fundamental aspect w_j such that both $\frac{\partial f_n}{\partial w_j}$ and $\frac{\partial f_{n'}}{\partial w_j}$, evaluated at current fundamental-aspect levels, are non-zero. Because our overlap-detection method relies on SP-survey scenarios involving small changes from current fundamental-aspect levels, it is designed to detect local overlap. Local overlap is a sufficient condition for global overlap. Moreover, under our assumption that each f_n is a strictly increasing function, local overlap is also a necessary condition for global overlap.

Let $\bar{w}_1, \dots, \bar{w}_J$ denote the respondent's current levels of the fundamental aspects. The current responses to the SWB survey are therefore $(\bar{r}_1, \dots, \bar{r}_N)$, where each \bar{r}_n is equal to the value of f_n evaluated at the current levels of its fundamental-aspect arguments. We consider scenarios on a SP survey that give the respondent a choice between two options, each of which is a specific vector of responses (r_1, \dots, r_N) in a neighborhood of $(\bar{r}_1, \dots, \bar{r}_N)$. Equivalently, we will describe each option as a vector of changes relative to current levels, $(\Delta r_1, \dots, \Delta r_N)$. We use the term **option** to refer to such a specified vector of changes (which corresponds to the way we use the term "option" in the main text). We note that in a typical option, many of the Δr_n 's will equal zero.

In order to analyze the change in utility from specified Δr_n 's, we need to describe what the respondent envisions in terms of changes in the fundamental aspects as a function of these Δr_n 's. To do so, we define a family of **interpretation functions**, one for each subset of responses that could be specified as changing in an option. For example, for any option where Δr_4 is non-zero and the other Δr_n 's equal zero, the vector-valued function $\mathbf{I}_4(\Delta r_4 | \bar{w}_1, \dots, \bar{w}_J) = (\Delta w_1, \dots, \Delta w_J)$ denotes the respondent's interpretation of what changes in the vector of fundamental aspects occurred as a function of the specified change in Δr_4 and of current fundamental-aspect levels. Similarly, for any option where Δr_5 is non-zero and the other Δr_n 's equal zero, the function $\mathbf{I}_5(\Delta r_5 | \bar{w}_1, \dots, \bar{w}_J) = (\Delta w_1, \dots, \Delta w_J)$ describes the respondent's interpretation in terms of fundamental-aspect changes. For any option where *both* Δr_4 and Δr_5 are non-zero but all other Δr_n 's are zero, the respondent's interpretation is described by $\mathbf{I}_{4,5}(\Delta r_4, \Delta r_5 | \bar{w}_1, \dots, \bar{w}_J) =$

$(\Delta w_1, \dots, \Delta w_J)$.

Each interpretation function is continuously differentiable and approaches the value $\mathbf{0}$ in the limit in which all its Δr_n arguments approach 0. By defining separate interpretation functions depending on the subset of responses that is specified as changing, we allow for the possibility that the interpretation of a change in a given response may depend on which other responses are also specified as changing (e.g., the interpretation of a change in life satisfaction can depend on whether life worthwhileness also changes). In particular, we do not assume that a respondent's interpretation is continuous when a response switches from being unchanged in an option to being specified as changed; for example, $I_4(\Delta r_4|\bar{w}_1, \dots, \bar{w}_J)$ is not required to be equal to $\lim_{\Delta r_5 \rightarrow 0} I_{4,5}(\Delta r_4, \Delta r_5|\bar{w}_1, \dots, \bar{w}_J)$ (and such discontinuities occur in many of the examples below). Each interpretation function may also take the value \emptyset , meaning that the respondent was unable to interpret the option, which would occur if the constraints (discussed below) on the I function cannot all be satisfied given the specified option. To accommodate this possibility, we require the SP survey to allow the respondent to tell us "this choice option does not make sense." Because $(\bar{w}_1, \dots, \bar{w}_J)$ is fixed in the analysis that follows, we suppress $I(\cdot)$'s dependence on it for brevity. We denote by $I^{(j)}(\cdot)$ the j^{th} element of the respondent's interpretation, that is, the interpreted change in fundamental-aspect j .

Implicit in our formulation of the interpretation functions is an assumption that the interpretation depends only on changes in responses specified in the option being evaluated, and not also on changes specified in the other option. We consider that assumption to be reasonable, but it could be made more likely to hold by instructing respondents to consider the two options independently of each other.

As an example of specific interpretation functions, the following are consistent with the example in subsection C.4.1 (recall that in the example, $N = 5$ and $J = 3$):

$$I_4(\Delta r_4) = (\Delta r_4, \Delta r_4, 0) \tag{C.7}$$

$$I_5(\Delta r_5) = (0, \Delta r_5, \Delta r_5) \quad (C.8)$$

$$I_{4,5}(\Delta r_4, \Delta r_5) = (\Delta r_4, \max \Delta r_4, \Delta r_5, \Delta r_5). \quad (C.9)$$

The interpretation function C.7 indeed implies, consistent with the example in subsection C.4.1, that a 1-unit increase in Δr_4 generates a 1-unit increase in each of w_1 and w_2 . Similarly, interpretation function C.8 implies that a 1-unit increase in Δr_5 generates a 1-unit increase in each of $w - 2$ and w_3 . And according to C.9, a joint 1-unit increase indeed implies a 1-unit increase in each of w_1 , w_2 , and w_3 .

We collect some basic assumptions regarding the interpretation functions that we believe are reasonable into the "same-sign constraint," which has three parts. First, a fundamental aspect is not envisioned to change unless it is an argument of at least one response that is specified as changing. Second, when only a single response is specified as changing, then all of its constituent fundamental aspects are envisioned to change at least a little in the same direction. Third, when changes in each of two responses would have been interpreted as generating the same direction of change in a fundamental aspect, then a joint change is interpreted as generating a change in the same direction. While the first part, and perhaps also the third part, may be intuitive (and unobjectionable), the second part is more substantive.

To facilitate formalizing the same-sign constraint, define $N_j := n | \Delta r_n \neq 0 \text{ and } w_j \in r_n$ to be the set identifying the responses for which w_j is an argument in the production function that are specified as changing.

Same-sign constraint:

- (i) For every interpretation function, if N_j is empty, then the interpretation function's implied change in w_j is zero.
- (ii) If $w_j \in r_n$ and $\Delta r_n > 0$, then $I_n^{(j)}(\Delta r_n) > 0$. (Similarly when the inequalities are replaced by $<$ and $<.$)
- (iii) If $I_n^{(j)}(\Delta r_n)$ and $I_{n'}^{(j)}(\Delta r_{n'})$ are both ≥ 0 with at least one inequality strict, then $I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'}) > 0$. (Similarly when the inequalities are replaced by \leq and $>$.)

\leq .)

To illustrate, suppose as in the example in subsection C.4.1 that $r_4 = f_4(w_1, w_2)$ and $r_5 = f_5(w_2, w_3)$. The first part implies: $I_4^{(3)}(\Delta r_4) = 0$ and $I_5^{(1)}(\Delta r_5) = 0$. The second part implies: if $\Delta r_4 > 0$, then $I_4^{(1)}(\Delta r_4) > 0$ and $I_4^{(2)}(\Delta r_4) > 0$. These together with the third part imply: if $\Delta r_4 > 0$ and $\Delta r_5 < 0$, then $I_{4,5}^{(0)}(\Delta r_4, \Delta r_5) > 0$ and $I_{4,5}^{(3)}(\Delta r_4, \Delta r_5) < 0$ (but the sign of $I_{4,5}^{(2)}(\Delta r_4, \Delta r_5)$ is not constrained); alternatively, if $\Delta r_4 < 0$ and $\Delta r_5 > 0$, then $I_{4,5}^{(1)}(\Delta r_4, \Delta r_5) > 0$, $I_{4,5}^{(2)}(\Delta r_4, \Delta r_5) > 0$, and $I_{4,5}^{(3)}(\Delta r_4, \Delta r_5) > 0$.

We will focus on options where the Δr_n 's, and implied Δw_j 's, are small. Doing so allows us to use the following approximations, which hold in a neighborhood of $(\bar{w}_1, \bar{w}_2, \bar{w}_3)$:

$$\Delta u \approx \sum_{j=1}^I \frac{\partial u}{\partial w_j} \Delta w_j$$

$$\Delta w_j \approx \sum_{n \text{ s.t. } w_j \in r_n} \frac{\partial I^{(j)}(\cdot)}{\partial \Delta r_n} \Delta r_n \text{ for all } j$$

$$\Delta r_n \approx \sum_{j \text{ s.t. } w_j \in r_n} \frac{\partial f_n}{\partial w_j} \Delta w_j \text{ for all } n$$

Due to these functions being locally linear, we can ignore a variety of possible complementarities: in preferences, in the production functions, and in the interpretation functions. Any such non-linearities would confound the inferences that can be drawn from comparing the relative marginal utility of a joint increase with the sum of the relative marginal utilities of separate increases.

Our reliance on small changes also justifies the possible use of any response

as a numeraire for the overlap-detection method. A commodity can be used as a numeraire if preferences are quasi-linear in that commodity, and due to the linear approximations, preferences are (approximately) quasi-linear in any response. To illustrate, suppose that $I_4(\Delta r_4) = (\Delta r_4, \Delta r_4, 0)$ consistent with the example in subsection C.4.1, and suppose that r_4 is used as the numeraire. For small Δr_4 's, utility is roughly linear in changes in the "commodity" ($w_1 + w_2$), and thus treating r_4 as the numeraire would be justifiable.

The same-sign constraint and changes being small are not by themselves sufficient to ensure that the overlap-detection method is valid; additional assumptions are needed. The two sets of assumptions outlined in the next two subsections (respectively) constitute alternative ways to complete the theoretical framework.

C.4.3 The composite-aspect approach

The first approach combines an assumption that the combination responses correspond to "composite aspects" with a constraint on the interpretation functions.

A response r_n corresponds to a **composite aspect** if there exists an alternative representation of preferences besides $u(\cdot)$, call it $v(\cdot)$, that is a function of r_n and of the fundamental aspects that are *not* arguments of f_n . For example, consider the set-up in subsection C.4.1 in which $J = 3$ and $N = 5$. If $r_4 = f_4(w_1, w_2)$ corresponds to a composite aspect, then there is a function $v(\text{cot})$ such that $u(w_1, w_2, w_3) = v(r_4, w_3)$. In words, the fundamental aspects that comprise a composite aspect whose level is conveyed by r_4 matter for preferences only via f_4 . Indeed, with production functions C.4 and C.5 and preferences that can be represented by C.6, r_4 corresponds to a composite aspect because the utility function can be re-expressed as $u = 2r_4 + w_3$, and r_5 corresponds to a composite aspect because the utility function can be re-expressed as $u = w_1 + 2r_5$. Intuitively, such "composite responses" are combination responses that could be viewed as sub-utility functions.

The additional constraint on the interpretation functions requires that the fundamental-aspect changes envisioned would actually produce (according to the production functions) the changes in responses specified in the option.

Consistency constraint: For every interpretation function and any Δr_n arguments of the interpretation function, the implied vector of Δw_j 's produces the Δr_n arguments of the interpretation function.

For example, for the interpretation function $I_{4,5}(\Delta r_4, \Delta r_5) = (\Delta w_1, \Delta w_2, \Delta w_3)$, the consistency constraint implies that for every $(\Delta r_4, \Delta r_5)$, the resulting fundamental-aspect vector (w_1, w_2, w_3) must satisfy $\Delta r_4 = f_4(w_1, w_2) - f_4(\bar{w}_1, \bar{w}_2)$ and $\Delta r_5 = f_5(w_2, w_3) - f_5(\bar{w}_2, \bar{w}_3)$. Given the production functions C.4 and C.5, the interpretation functions C.7 and C.8 satisfy the consistency constraint, but interpretation function C.9 does not: for example, $I_{4,5}(1, 2) = (1, 2, 2)$, but the change in r_4 produced by the implied changes in w_1 and w_2 is $1\frac{1}{2}$.

Note that the consistency constraint only requires that the envisioned fundamental-aspect changes be consistent with the responses that are explicitly specified in the option. It does *not* additionally require consistency with Δr_n 's that are not explicitly specified as changing in an option. If it were modified to have this additional requirement, then the modified constraint would mean that a respondent is unable to interpret an option that specifies only a change in a combination response, since a change in a combination response also implies a change in at least one fundamental response. For example, $I_4(\Delta r_4)$ would be un-interpretable because Δr_4 implies a non-zero change in Δr_1 or Δr_2 , but neither is specified as changing. Under this modified constraint, identifying combination responses would be easy: respondents could be asked a series of SP-survey scenarios where each option specifies a change in exactly one of the responses. If the option specified a change in a fundamental response, then the respondent would be able to interpret the option, while if the option specified a change in a combination response, then the respondent would report that "this choice option does not make sense." We believe that respondents in fact would not have difficulty interpreting options that specified a change only in a combina-

tion response, and therefore we believe the modified version of the consistency constraint is implausible.

Even with the (unmodified) consistency constraint as stated above, for some options the respondent's interpretation would be \emptyset . This would occur, for example, if two responses directly contradicted each other in what they imply for the change in some fundamental aspect. In such a case, there does not exist any interpretation function that would satisfy the consistency constraint.

A respondent would also have an interpretation of \emptyset if the consistency constraint and the same-sign constraint could not be satisfied simultaneously for the responses specified in a particular option. To understand this point, consider again the production functions C.4 and C.5. Although interpretation function C.9 does not satisfy the consistency constraint, the following interpretation function both satisfies the consistency constraint and fits the example interpretation from subsection C.4.1 (i.e., it has the property that $I_{4,5}(1, 1) = 1$):

$$I_{4,5}(\Delta r_4, \Delta r_5) = \left(\frac{3}{2}\Delta r_4 - \frac{1}{2}\Delta r_5, \frac{1}{2}\Delta r_4 + \frac{1}{2}\Delta r_5, \frac{3}{2}\Delta r_5 - \frac{1}{2}\Delta r_4 \right). \quad (\text{C.10})$$

It may seem strange that an increase in r_4 is interpreted as *decreasing* w_3 , especially since w_3 is not even an argument of r_4 's production function. However, this feature of the interpretation function is necessitated by the consistency constraint! The reason is that an increase in r_4 implies an increase in w_2 , which taken by itself would produce an increase in r_5 ; in order to *not* affect r_5 , the increase in r_4 has to also decrease w_3 . Symmetrically, the increase in r_5 necessitates a decrease in w_1 in order to avoid affecting r_4 . However, the consistency constraint's implication that some of the implied w_j 's decrease when the r_n 's increase can clash with the same-sign constraint's requirement that these w_j 's increase. For example, the above interpretation C.10 violates the same-sign constraint if Δr_4 and Δr_5 are both positive and $\frac{\Delta r_5}{\Delta r_4} > 3$. If a respondent had interpretation C.10, then the respondent would envision the changes in fundamental aspects according to equation C.10 as long as doing so satisfies the same-sign constraint,

but the respondent's interpretation would be \emptyset if the same-sign constraint were violated.

The following proposition demonstrates that these assumptions are sufficient to justify the overlap-detection method.

Proposition 16. *Suppose that combination responses correspond to composite aspects, and suppose that the interpretation functions satisfy the same-sign constraint and the consistency constraint. For small $\Delta r_n > 0$ and $\Delta r_{n'} > 0$ such that none of the relevant interpretations are \emptyset : if r_n and $r_{n'}$ do not locally overlap, then*

$$\Delta u(\mathbf{I}_{n,n'}(\Delta r_n, \Delta r_{n'})) \approx \Delta u(\mathbf{I}_n(\Delta r_n)) + \Delta u(\mathbf{I}_{n'}(\Delta r_{n'}));$$

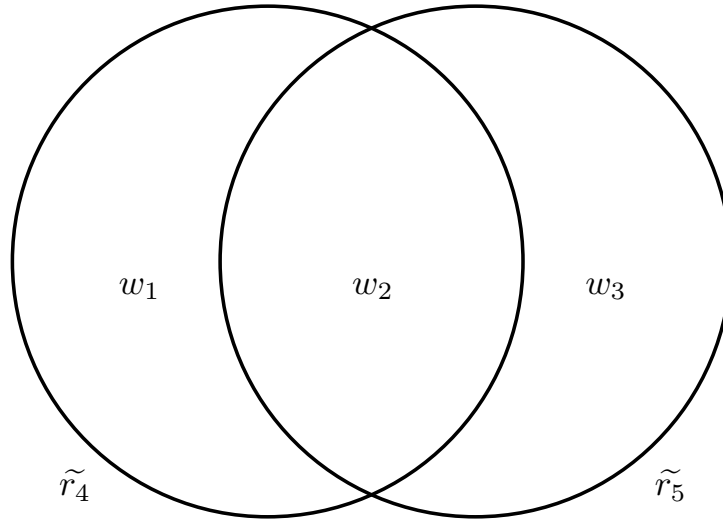
while if r_n and $r_{n'}$ locally overlap, then

$$\Delta u(\mathbf{I}_{n,n'}(\Delta r_n, \Delta r_{n'})) < \Delta u(\mathbf{I}_n(\Delta r_n)) + \Delta u(\mathbf{I}_{n'}(\Delta r_{n'}));$$

Figure C.1 illustrates the logic underlying the proposition using a Venn diagram. We suppose the production functions are given by equations C.4 and C.5, and preferences are represented by equation C.6. The fundamental aspects w_1 , w_2 , and w_3 are drawn as having equal areas since their marginal utilities are equal (in general, the areas would be proportional to the marginal utilities). Due to the composite-aspect assumption, we can define re-scaled versions of the combination responses that are subutility functions of u : $\tilde{r}_4 = 2r_4$ and $\tilde{r}_5 = 2r_5$. These re-scaled composite aspects can be represented graphically as the union of the areas of the fundamental aspects they comprise. The same-sign constraint implies that a joint increase in r_4 and r_5 must involve an increase in all three fundamental aspects. The consistency constraint implies that a weighted average of the increases in w_1 and w_2 , with weights equal to their respective areas, must equal the specified increase in \tilde{r}_4 . Similarly, a weighted average of the increases in w_2 and w_3 , with weights equal to their respective areas, must equal the specified increase in \tilde{r}_5 . The net increase in utility is the area-weighted average of the increases in all three fundamental aspects. But since the increase in w_2 is shared,

the gain in utility from the joint increase is smaller than the sum of the gains in utility from separate increases.

Figure C.1: Illustration for Proposition 16



Neither the composite-aspect assumption nor the consistency constraint without the other is sufficient for Proposition 16. To see the necessity of the composite-aspect assumption, continue to suppose that the production functions are given by equations C.4 and C.5, but now suppose that preferences can be represented by $u(w_1, w_2, w_3) = 4w_1 + w_2 + 4w_3$ so that r_4 and r_5 do not correspond to composite aspects. Suppose that the interpretation functions, which satisfy the consistency constraint, are given by $I_4(\Delta r_4) = (\frac{1}{2}\Delta r_4, \frac{3}{2}\Delta r_4, 0)$, $I_5(\Delta r_5) = (0, \frac{3}{2}\Delta r_5, \frac{1}{2}\Delta r_5)$, and $I_{4,5}(\Delta r_4, \Delta r_5) = (\frac{7}{4}\Delta r_4 - \frac{1}{4}\Delta r_5, \frac{1}{4}\Delta r_4 + \frac{1}{4}\Delta r_5, \frac{7}{4}\Delta r_5 - \frac{1}{4}\Delta r_4)$. The gain in utility from separate 1-unit increases in r_4 and r_5 are each $4(\frac{1}{2}) + 1(\frac{3}{2}) = 3\frac{1}{2}$, but the gain in utility from a joint 1-unit increase in both r_4 and r_5 is: $[\frac{7}{4}(4) - \frac{1}{4}(4)] + [\frac{1}{4}(1) + \frac{1}{4}(1)] + [\frac{7}{4}(4) - \frac{1}{4}(4)] = 12\frac{1}{2}$. It is *greater* than the sum of gains in utility from the separate increases. What went "wrong" here is that the joint increase in r_4 and r_5 is interpreted as involving greater increases in w_1 and w_3 than the separate increases would have, and w_1 and w_3 are particularly valuable fundamental

aspects.

A simpler example shows that the composite-aspect assumption alone is not sufficient. Consider applying the overlap-detection method to non-overlapping responses, r_1 and r_2 . Suppose $I_1(\Delta r_1) = (\Delta r_1, 0, 0)$, $I_2(\Delta r_2) = (0, \Delta r_2, 0)$, and $I_{1,2}(\Delta r_1, \Delta r_2) = (\frac{1}{2}\Delta r_1, \Delta r_2, 0)$, meaning that a 1-unit increase in "how you would say your health is" is interpreted as a 1-unit increase in health when it appears alone in an option but as a $\frac{1}{2}$ -unit increase when it appears together with an increase in "how happy you felt yesterday." In such a case, it would not be true that the joint marginal utility is equal to the sum of the separate marginal utilities. (If there were reason to be concerned about such an "interference effect," respondents could be instructed to consider different rows in the aspect table independently if doing so is possible.)

We conclude this subsection by noting that if the combination responses correspond to composite aspects, then in accordance with what we note in footnote 30 of the main text, they could be substituted in the index for the fundamental responses corresponding with their underlying fundamental aspects.

C.4.4 The averaging-interpretation approach

The second approach—which does not require assuming that the combination responses correspond to composite aspects—does not impose the consistency constraint but instead imposes the "averaging constraint." To facilitate formalizing this constraint, we refer to a function $A(x_1, \dots, x_n)$ as an n -argument **generalized averaging function** if it is continuous and satisfies $\min\{x_1, \dots, x_n\} \leq A(x_1, \dots, x_n) \leq \max\{x_1, \dots, x_n\}$ for all x_1, \dots, x_n .

Averaging constraint: For every interpretation function, if N_j is non-empty, then there exists an $|N_j|$ -argument generalized averaging function A such that the interpretation function's implied change in w_j is

$$A\left(\{I_n^{(j)}(\Delta r_n)\}_{n \in N_j}\right).$$

The constraint states that, for any fundamental aspect, the interpretation of a joint change in responses is weakly in between the minimum and maximum change that would be implied by separate changes in the responses. The interpretation functions C.7-C.9, which fit the example from subsection C.4.1, satisfy the averaging constraint.

To give another example, suppose that the separate interpretations for r_4 and r_5 are:

$$I_4(\Delta r_4) = (\Delta r_4, \Delta r_4, 0) \quad (\text{C.11})$$

$$I_5(\Delta r_5) = \left(0, \frac{3}{2}\Delta r_5, \frac{1}{2}\Delta r_5\right). \quad (\text{C.12})$$

Each of the following interpretation functions for a joint increase would satisfy the averaging constraint:

$$I_{4,5}(\Delta r_4, \Delta r_5) = \left(\Delta r_4, \Delta r_4, \frac{1}{2}\Delta r_5\right)$$

$$I_{4,5}(\Delta r_4, \Delta r_5) = \left(\Delta r_4, \left(\frac{1}{4}\right)\Delta r_4 + \left(\frac{3}{4}\right)\frac{3}{2}\Delta r_5, \frac{1}{2}\Delta r_5\right)$$

$$I_{4,5}(\Delta r_4, \Delta r_5) = \left(\Delta r_4, \min\{\Delta r_4, \frac{3}{2}\Delta r_4\}, \frac{1}{2}\Delta r_5\right).$$

The value of Δw_3 must be $\frac{1}{2}\Delta r_5$ because r_5 is the only response specified as changing that relates to w_3 , and therefore nothing else is being averaged with the change in w_3 implied by a separate change in r_5 , namely $\frac{1}{2}\Delta r_5$. Similarly, the value of Δw_1 must be Δr_4 . For Δw_2 , each of the three interpretations corresponds to a different generalized-averaging function for a separate change in r_4 or r_5 : $A(\Delta r_4, \frac{3}{2}\Delta r_5) = \Delta r_4$, $A(\Delta r_4, \frac{3}{2}\Delta r_5) = \left(\frac{1}{4}\right)\Delta r_4 + \left(\frac{3}{4}\right)\frac{3}{2}\Delta r_5$, or $A(\Delta r_4, \frac{3}{2}\Delta r_5) = \min\{\Delta r_4, \frac{3}{2}\Delta r_4\}$.

Neither the averaging constraint nor the consistency constraint implies the other. For example, as noted above, given production functions C.4 and C.5, interpretation function C.9 satisfies the averaging constraint but not the consistency constraint. While interpretation functions C.7, C.8, and C.10 satisfy the

consistency constraint, they violate the averaging constraint: $I_4^{(1)}(2) = 2$ and $I_5^{(1)}(1) = 0$, $I_{4,5}^{(1)}(2, 1) = 2\frac{1}{2}$, which is greater than both.

Note that if the consistency constraint is not imposed, then the production functions for the responses do not play a role in determining a respondent's interpretation of an option. In large part due to that fact, there exist families of interpretation functions that satisfy the same-sign constraint and the averaging constraint for *any* option, and therefore there is no reason for the interpretation to ever take the value \emptyset when only these constraints are imposed.

The SP-survey instructions could be written to discourage respondents from trying to satisfy the consistency constraint and encourage them to satisfy the averaging constraint. In particular, the instructions could state that the rows of the aspect table should not be understood as all being true, but rather as collectively describing the overall sense of the option, and with one row possibly overriding another. Alternatively or additionally, respondents could be explicitly instructed to envision the option as being the average of what is described across the rows of the aspect table. We emphasize here, as above, that survey instructions would need to be carefully formulated and empirically tested before being used in practice.

The following proposition establishes that the same-sign and averaging constraints taken together are sufficient for the overlap-detection method to be valid.

Proposition 17. *Suppose that the interpretation functions satisfy the same-sign constraint and the averaging constraint. For small $\Delta r_n > 0$ and $\Delta r_{n'} > 0$: if r_n and $r_{n'}$ do not locally overlap, then*

$$\Delta u(I_{n,n'}(\Delta r_n, \Delta r_{n'})) \approx \Delta u(I_n(\Delta r_n)) + \Delta u(I_{n'}(\Delta r_{n'}));$$

while if r_n and $r_{n'}$ locally overlap, then

$$\Delta u(I_{n,n'}(\Delta r_n, \Delta r_{n'})) < \Delta u(I_n(\Delta r_n)) + \Delta u(I_{n'}(\Delta r_{n'}));$$

The intuition underlying why the averaging constraint implies the last inequality is that, for each fundamental aspect that is envisioned to increase, the sum of the separate gains in utility due to the increase in that aspect is necessarily greater than the average of those gains. Consider a numerical example with interpretations C.11, C.12, and $I_{4,5}(\Delta r_4, \Delta r_5) = (\Delta r_4, \min\{\Delta r_4, \frac{3}{2}\Delta r_4\}, \frac{1}{2}\Delta r_5)$, and with preferences represented by utility function C.6. The gain in utility from a separate 1-unit increase in r_4 is $1(1) + 1(1) = 2$, and the gain from a separate 1-unit increase in r_5 is $\frac{3}{2}(1) + \frac{1}{2}(1) = 2$ so the sum is 4. The gain in utility from the joint 1-unit increase is $1(1) + 1(1) + \frac{1}{2}(1) = 2\frac{1}{2}$, which is smaller.

In this appendix, we have explored one SP-survey-based overlap-detection method, and we have explored two sets of constraints on respondents' interpretations that would justify it. There may well be other plausible constraints that respondents could be encouraged to satisfy that would also validate the method we have considered, and there may be other reasonable overlap-detection methods that are altogether distinct. These remain open questions for future research.

C.4.5 Proofs

Proposition 16: Suppose that combination responses correspond to composite aspects, and suppose that the interpretation functions satisfy the same-sign constraint and the consistency constraint. For small $\Delta r_n > 0$ and $\Delta r_{n'} > 0$ such that none of the relevant interpretations are \emptyset : if r_n and $r_{n'}$ do not locally overlap, then

$$\Delta u(I_{n,n'}(\Delta r_n, \Delta r_{n'})) \approx \Delta u(I_n(\Delta r_n)) + \Delta u(I_{n'}(\Delta r_{n'}));$$

while if r_n and $r_{n'}$ locally overlap, then

$$\Delta u(I_{n,n'}(\Delta r_n, \Delta r_{n'})) < \Delta u(I_n(\Delta r_n)) + \Delta u(I_{n'}(\Delta r_{n'})).$$

Proof. We first focus on the right-hand side of both expressions in the proposition. The same-sign constraint implies that if $w_j \notin r_n$ then $I_n^{(j)}(\Delta r_n) = 0$. The con-

sistency constraint implies that the changes in the fundamental aspects implied by $I_n(\Delta r_n)$ in fact produce Δr_n . Local linearity, together with r_n being a composite response (i.e., a response corresponding to a composite aspect), implies that $\Delta u(I_n(\Delta r_n)) \approx \frac{\partial v_n}{\partial r_n} \Delta r_n$, where $v_n(\cdot)$ is the alternative representation of $u(\cdot)$ that depends on r_n . Similarly, $\Delta u(I_{n'}(\Delta r_{n'})) \approx \frac{\partial v_{n'}}{\partial r_{n'}} \Delta r_{n'}$, where $v_{n'}(\cdot)$ is the alternative representation of $u(\cdot)$ that depends on $r_{n'}$. Hence, $\Delta u(I_n(\Delta r_n)) + \Delta u(I_{n'}(\Delta r_{n'})) \approx \frac{\partial v_n}{\partial r_n} \Delta r_n + \frac{\partial v_{n'}}{\partial r_{n'}} \Delta r_{n'}$. We now turn to the left-hand side of both expressions in the proposition. Local linearity implies that

$$I_{n,n'}(\Delta r_n, \Delta r_{n'}) \approx \left(\frac{\partial I_{n,n'}^{(1)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_n} \Delta r_n + \frac{\partial I_{n,n'}^{(1)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_{n'}} \Delta r_{n'}, \dots, \frac{\partial I_{n,n'}^{(J)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_n} \Delta r_n + \frac{\partial I_{n,n'}^{(J)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_{n'}} \Delta r_{n'} \right).$$

Using local linearity again,

$$\Delta u(I_{n,n'}(\Delta r_n, \Delta r_{n'})) \approx \sum_j \frac{\partial u}{\partial w_j} \left(\frac{\partial I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_n} \Delta r_n + \frac{\partial I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_{n'}} \Delta r_{n'} \right).$$

We now decompose the set of all fundamental aspects into those that are arguments of r_n , those that are arguments of $r_{n'}$, and those that are arguments of both (the same-sign constraint implies that no other fundamental aspects change):

$$\begin{aligned} \Delta u(I_{n,n'}(\Delta r_n, \Delta r_{n'})) &\approx \sum_{j \text{ s.t. } w_j \in r_n} \frac{\partial u}{\partial w_j} \left(\frac{\partial I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_n} \Delta r_n + \frac{\partial I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_{n'}} \Delta r_{n'} \right) \\ &+ \sum_{j \text{ s.t. } w_j \in r_{n'}} \frac{\partial u}{\partial w_j} \left(\frac{\partial I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_n} \Delta r_n + \frac{\partial I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_{n'}} \Delta r_{n'} \right) \\ &- \sum_{j \text{ s.t. } w_j \in r_n, w_j \in r_{n'}} \frac{\partial u}{\partial w_j} \left(\frac{\partial I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_n} \Delta r_n + \frac{\partial I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'})}{\partial \Delta r_{n'}} \Delta r_{n'} \right) \end{aligned}$$

The consistency constraint implies that the first summation is the first-order effect on utility from Δr_n , which equals $\frac{\partial v_n}{\partial r_n} \Delta r_n$ due to the composite-aspect assumption. Similarly, the second summation is the first-order effect on utility

from $\Delta r_{n'}$, which equals $\frac{\partial v_{n'}}{\partial r_{n'}} \Delta r_{n'}$. If r_n and $r_{n'}$ do not overlap, then the third summation is zero because the set of fundamental aspects over which the sum is taken is empty. If r_n and $r_{n'}$ overlap, then the set is non-empty, and the same-sign constraint implies that the third summation is strictly positive. The result follows. \square

Proposition 17: Suppose that the interpretation functions satisfy the same-sign constraint and the averaging constraint. For small $\Delta r_n > 0$ and $\Delta r_{n'} > 0$: if r_n and $r_{n'}$ do not locally overlap, then

$$\Delta u(I_{n,n'}(\Delta r_n, \Delta r_{n'})) \approx \Delta u(I_n(\Delta r_n)) + \Delta u(I_{n'}(\Delta r_{n'}));$$

while if r_n and $r_{n'}$ locally overlap, then

$$\Delta u(I_{n,n'}(\Delta r_n, \Delta r_{n'})) < \Delta u(I_n(\Delta r_n)) + \Delta u(I_{n'}(\Delta r_{n'})).$$

Proof. We first focus on the right-hand side of both expressions in the proposition. The first part of the same-sign constraint implies that if $w_j \notin r_{n'}$, then $\frac{\partial I_n^{(j)}(\Delta r_n)}{\partial \Delta r_n} = 0$. That fact, together with local linearity of $u(\cdot)$ and $I^{(j)}(\cdot)$, implies:

$$\begin{aligned} \Delta u(I_n(\Delta r_n)) &\approx \sum_{j \text{ s.t. } w_j \in r_n} \frac{\partial u}{\partial w_j} \left(\frac{\partial I_n^{(j)}(\Delta r_n)}{\partial \Delta r_n} \Delta r_n \right) \\ \Delta u(I_{n'}(\Delta r_{n'})) &\approx \sum_{j \text{ s.t. } w_j \in r_{n'}} \frac{\partial u}{\partial w_j} \left(\frac{\partial I_{n'}^{(j)}(\Delta r_{n'})}{\partial \Delta r_{n'}} \Delta r_{n'} \right) \end{aligned}$$

Adding these together and decomposing the set of all fundamental aspects into those that are arguments of r_n but not $r_{n'}$, those that are arguments of $r_{n'}$ but not r_n , and those that are arguments of both:

$$\Delta u(I_n(\Delta r_n)) + \Delta u(I_{n'}(\Delta r_{n'})) \approx \sum_{j \text{ s.t. } w_j \in r_n, w_j \notin r_{n'}} \frac{\partial u}{\partial w_j} \left(\frac{\partial I_n^{(j)}(\Delta r_n)}{\partial \Delta r_n} \Delta r_n \right)$$

$$\begin{aligned}
& + \sum_{j \text{ s.t. } w_j \notin r_n, w_j \in r_{n'}} \frac{\partial u}{\partial w_j} \left(\frac{\partial I_{n'}^{(j)}(\Delta r_{n'})}{\partial \Delta r_{n'}} \Delta r_{n'} \right) \\
& + \sum_{j \text{ s.t. } w_j \in r_n, w_j \in r_{n'}} \frac{\partial u}{\partial w_j} \left(I_n^{(j)}(\Delta r_n) + I_{n'}^{(j)}(\Delta r_{n'}) \right).
\end{aligned}$$

We now turn to the left-hand side of both expressions in the proposition. The averaging constraint and the same-sign constraint together imply: for any j 's such that $w_j \notin r_n$ and $w_j \notin r_{n'}$, $I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'}) \equiv 0$; for any j 's such that $w_j \in r_n$ and $w_j \notin r_{n'}$, $I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'}) \equiv I_n^{(j)}(\Delta r_n)$; for any j 's such that $w_j \notin r_n$ and $w_j \in r_{n'}$, $I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'}) \equiv I_{n'}^{(j)}(\Delta r_{n'})$; and for any j 's such that $w_j \in r_n$ and $w_j \in r_{n'}$, $I_{n,n'}^{(j)}(\Delta r_n, \Delta r_{n'}) \equiv A \left(I_n^{(j)}(\Delta r_n), I_{n'}^{(j)}(\Delta r_{n'}) \right)$. Hence

$$\begin{aligned}
\Delta u(I_{n,n'}(\Delta r_n, \Delta r_{n'})) & \approx \sum_{j \text{ s.t. } w_j \in r_n, w_j \notin r_{n'}} \frac{\partial u}{\partial w_j} \left(\frac{\partial I_n^{(j)}(\Delta r_n)}{\partial \Delta r_n} \Delta r_n \right) \\
& + \sum_{j \text{ s.t. } w_j \notin r_n, w_j \in r_{n'}} \frac{\partial u}{\partial w_j} \left(\frac{\partial I_{n'}^{(j)}(\Delta r_{n'})}{\partial \Delta r_{n'}} \Delta r_{n'} \right) \\
& + \sum_{j \text{ s.t. } w_j \in r_n, w_j \in r_{n'}} \frac{\partial u}{\partial w_j} \left(A \left(I_n^{(j)}(\Delta r_n), I_{n'}^{(j)}(\Delta r_{n'}) \right) \right).
\end{aligned}$$

Thus, the right-hand side and the left-hand sides of the expressions in the proposition are approximately equal, except for the third summation. If r_n and $r_{n'}$ do not overlap, then the third summation is zero because the set of fundamental aspects over which the sum is taken is empty. If r_n and $r_{n'}$ do overlap, then the same-sign constraint implies that $I_n^{(j)}(\Delta r_n)$ and $I_{n'}^{(j)}(\Delta r_{n'})$ are strictly positive for all j , and therefore so are the third summations. Moreover, by definition of the generalized averaging function, $A \left(I_n^{(j)}(\Delta r_n), I_{n'}^{(j)}(\Delta r_{n'}) \right) \leq \max \left\{ I_n^{(j)}(\Delta r_n), I_{n'}^{(j)}(\Delta r_{n'}) \right\} < I_n^{(j)}(\Delta r_n) + I_{n'}^{(j)}(\Delta r_{n'})$. The result follows. \square

BIBLIOGRAPHY

- [1] Adler, Matthew D. 2013. "Happiness Surveys and Public Policy: Whats the Use?" *Duke Law Journal* 62(8): 1509-1601.
- [2] Adler, Matthew D., and Paul Dolan. 2008. "Introducing a 'Different Lives' Approach to the Valuation of Health and Well-Being." University of Pennsylvania Law School ILE Research Paper 08-05, available at <http://ssrn.com/abstract=1112636>, March.
- [3] Akerlof, George A. 1970. "The Market for "Lemons": Quality Uncertainty and the Market Mechanism." *The Quarterly Journal of Economics*, 84(3): 488-500.
- [4] Alkire, Sabina. 2002. "Dimensions of Human Development." *World Development*, 30(2): 181-205.
- [5] Anderson, Simon P. and Kieron J. Meagher. 2012. "Choosing a Champion: Party Membership and Policy Platform." CEPR Discussion Paper 8941.
- [6] Aragonès, Enriqueta and Andrew Postlewaite. 2002. "Ambiguity in Election Games." *Review of Economic Design*, 7(3): 233-255.
- [7] Aragonès, Enriqueta and Zvika Neeman. 2000. "Strategic Ambiguity in Electoral Competition." *Journal of Theoretical Politics*, 12(2): 183-204.
- [8] Agranov, Marina. 2012. "Flip-Flopping, Intense Primaries and the Selection of Candidates." <http://hss.caltech.edu/magranov/documents/primaries.pdf>
- [9] Alesina, Alberto and Alex Cukierman. 1990. "The Politics of Ambiguity." *The Quarterly Journal of Economics*, 105(4): 829-850.
- [10] Alesina, Alberto F. and Richard R. Holden. 2008. "Ambiguity and Extremism in Elections." NBER Working Paper 14143.
- [11] Battaglini, Marco, Rebecca B. Morton, and Thomas R. Palfrey. 2010. "The Swing Voter's Curse in the Laboratory." *Review of Economic Studies*, 77(1): 61-89.
- [12] Becker, Gordon M., Morris H. Degroot, and Jacob Marschak. 1964. "Measuring Utility by a Single-Response Sequential Method." *Behavioral Science*, 9(3): 226-232.

- [13] Benjamin, Daniel J., Ori Heffetz, Miles S. Kimball, and Alex Rees-Jones. 2012. "What Do You Think Would Make You Happier? What Do You Think You Would Choose?" *American Economic Review*, 102(5): 2083-2110.
- [14] Benjamin, Daniel J., Ori Heffetz, Miles S. Kimball, and Alex Rees-Jones. 2013. "Can Marginal Rates of Substitution Be Inferred From Happiness Data? Evidence from Residency Choices." NBER Working Paper No. 18927.
- [15] Benjamin, Daniel J., Ori Heffetz, Miles S. Kimball, and Nichole Szembrot. 2013. "Aggregating Local Preferences to Guide Marginal Policy Adjustments." *American Economic Review Papers and Proceedings*, 103(3): 605-610.
- [16] Bernhardt, M. Daniel and Daniel E. Ingberman. 1985. "Candidate Reputations and the 'Incumbency Effect.'" *Journal of Public Economics*, 27(1): 47-67.
- [17] Black, Duncan. 1958. *The Theory of Committees and Elections*. Cambridge [Eng.]: University Press.
- [18] Brown, Alexander L., Colin F. Camerer, and Dan Lovallo. 2012. "To Review or Not to Review? Limited Strategic Thinking at the Box Office." *American Economic Journal: Microeconomics*, 4(2): 1-26.
- [19] Callander, Steven and Catherine H. Wilson. 2008. "Context-Dependent Voting and Political Ambiguity." *Journal of Public Economics* 92(3/4): 565-581.
- [20] Calvert, Randall L. 1985. "Robustness of the Multidimensional Voting Model: Candidate Motivations, Uncertainty, and Convergence." *American Journal of Political Science*, 29(1): 69-95.
- [21] Camerer, Colin F., and Robin M. Hogarth. 1999. "The Effects of Financial Incentives in Experiments: A Review and Capital-Labor-Production Framework." *Journal of Risk and Uncertainty*, 19(1-3): 742.
- [22] Camerer, Colin F., Samuel Issacharoff, George Loewenstein, Ted O'Donoghue, and Matthew Rabin. 2003. "Regulation for Conservatives: Behavioral Economics and the Case for 'Asymmetric Paternalism.'" *University of Pennsylvania Law Review*, 151(3): 1211-1254.
- [23] Carrillo, Juan D. and Thomas R. Palfrey. 2009. "The Compromise Game: Two-Sided Adverse Selection in the Laboratory." *American Economic Journal: Microeconomics*, 1(1): 151-181.

- [24] Chappell, Henry W., Jr. 1994. "Campaign Advertising and Political Ambiguity." *Public Choice*, 79(3/4): 281-303.
- [25] Crawford, Vincent P. and Nagore Iriberri. 2007. "Level-k Auctions: Can a Nonequilibrium Model of Strategic Thinking Explain the Winner's Curse and Overbidding in Private-Value Auctions?" *Econometrica*, 75(6): 1721-1770.
- [26] Deaton, Angus, Daniel Kahneman, Alan Krueger, David Schkade, Norbert Schwarz, and Arthur Stone. 2011. Memo to the Office of National Statistics' Advisory Group on Subjective Well-Being. Published in the Supporting Documents for the Meeting to Provide Guidance to the Organisation for Economic Co-operation and Development on its Plans to Measure Self-Reported Well-Being held on July 8, 2011.
- [27] Decancq, Koen, and María Ana Lugo. 2013. "Weights in Multidimensional Indices of Well-Being: An Overview." *Econometric Reviews*, 32(1): 734.
- [28] Decancq, Koen, Luc Van Ootegem, and Elsy Verhofstadt. 2011. "What if we voted on the weights of a multidimensional well-being index? An illustration with Flemish data." University of Antwerp CSB Working Paper No. 11/10, November.
- [29] Dellas, Harris and Vally Koubi. 1994. "Smoke Screen: A Theoretical Framework." *Public Choice*, 78(3/4): 351-358.
- [30] Diener, Ed. 2000. "Subjective Well-Being: The Science of Happiness and a Proposal for a National Index." *American Psychologist*, 55(1): 3443.
- [31] Diener, Ed. 2006. "Guidelines for National Indicators of Subjective Well-Being and Ill-Being." *Applied Research in Quality of Life*, 1: 151157.
- [32] Diener, Ed, and Martin E.P. Seligman. 2004. "Beyond money: Toward an economy of well-being." *Psychological Science in the Public Interest*, 5: 131.
- [33] Ding, Min, Rajdeep Grewal, and John Liechty. 2005. "Incentive-Aligned Conjoint Analysis." *Journal of Marketing Research*, 42(1): 6782.
- [34] Dolan, Paul, Richard Layard, and Robert Metcalfe. 2011. "Measuring Subjective Well-being for Public Policy." Office for National Statistics.

- [35] Dranove, David and Ginger Zhe Jin. 2010. "Quality Disclosure and Certification: Theory and Practice." *Journal of Economic Literature*, 48(4): 935-963.
- [36] Eyster, Erik and Matthew Rabin. 2005. "Cursed Equilibrium." *Econometrica*, 73(5): 1623-1672.
- [37] Fischbacher, Urs. 2007. "z-Tree: Zurich Toolbox for Ready-made Economic Experiments." *Experimental Economics*, 10(2): 171-178.
- [38] Fleurbaey, Marc. 2009. "Beyond GDP: The Quest for a Measure of Social Welfare." *Journal of Economic Literature*, 47(4): 1029-1075.
- [39] Fleurbaey, Marc, and Didier Blanchet. 2013. *Beyond GDP: Measuring Welfare and Assessing Sustainability*. Oxford: Oxford University Press.
- [40] Fleurbaey, Marc, and François Maniquet. 2011. *A Theory of Fairness and Social Welfare*. New York: Cambridge University Press.
- [41] Fleurbaey, Marc, Erik Schokkaert, and Koen Decancq. 2009. "What good is happiness?" CORE Discussion Paper 17, March.
- [42] Frey, Bruno, and Alois Stutzer. 2007. "Should national happiness be maximized?" Institute for Empirical Research in Economics (University of Zurich) Working Paper No. 306.
- [43] Frey, Bruno, and Alois Stutzer. 2012. "The use of happiness research for public policy." *Social Choice and Welfare*, 38(4): 659-674.
- [44] Gilbert, Daniel T. 2006. *Stumbling on Happiness*. New York: Knopf.
- [45] Gneezy, Uri, John A. List, and George Wu. 2006. "The Uncertainty Effect: When a Risky Prospect is Valued Less than its Worse Possible Outcome." *The Quarterly Journal of Economics*, 121(4): 1283-1309.
- [46] Graham, Carol. 2011. *The Pursuit of Happiness: An Economy of Well-Being*. Washington, D.C.: Brookings Institution Press.
- [47] Green, Paul E., and Vithala R. Rao. 1971. "Conjoint Measurement for Quantifying Judgmental Data." *Journal of Marketing Research*, 8(3): 355-363.
- [48] Heffetz, Ori, and Robert H. Frank. 2011. "Preferences for Status: Evidence and Economic Implications." In *Handbook of Social*

Economics Vol. 1A, edited by Jess Benhabib, Alberto Bisin, and Matthew Jackson: 6991. Amsterdam: North-Holland.

- [49] Heffetz, Ori, and Matthew Rabin. 2013. "Conclusions Regarding Cross-Group Differences in Happiness Depend on Difficulty of Reaching Respondents." *American Economic Review*, 103(7): 3001-21.
- [50] Jensen, Thomas. 2009. "Projection Effects and Strategic Ambiguity in Electoral Competition." *Public Choice*, 141(1/2): 213-232.
- [51] Kahneman, Daniel, and Angus S. Deaton. 2010. "High Income Improves Evaluation of Life but not Emotional Well-Being." *Proceedings of the National Academy of Sciences*, 107(38): 1648916493.
- [52] Kahneman, Daniel, and Alan B. Krueger. 2006. "Developments in the Measurement of Subjective Well-Being." *Journal of Economic Perspectives*, 20(1): 324.
- [53] Kartik, Navin and R. Preston McAfee. 2007. "Signaling Character in Electoral Competition." *The American Economic Review*, 97(3): 852-870.
- [54] Lancaster, Kelvin J. 1966. "A New Approach to Consumer Theory." *Journal of Political Economy* 74(2): 132157.
- [55] Layard, Richard. 2005. *Happiness: Lessons from a New Science*. The Penguin Press.
- [56] Loewenstein, George, and Peter A. Ubel. 2008. "Hedonic Adaptation and the Role of Decision and Experience Utility in Public Policy." *Journal of Public Economics*, 92(8-9): 17951810.
- [57] Maslow, Abraham. 1946. "Theory of Human Motivation." In *Twentieth century psychology: recent developments in psychology*, ed. Philip Lawrence Harriman. New York, NY: Philosophical Library.
- [58] McKelvey, Richard D. and Peter C. Ordeshook. 1990. "A Decade of Experimental Research on Spatial Models of Elections and Committees." In *Advances in the Spatial Theory of Voting*, ed. James M. Enelow and Melvin J. Hinich, 99-144. New York: Cambridge University Press.
- [59] McKelvey, Richard D. and Talbot Page. 1990. "Public and Private Information: An Experimental Study of Information Pooling." *Econometrica*, 58(6): 1321-1339.

- [60] Meirowitz, Adam. 2005. "Informational Party Primaries and Strategic Ambiguity." *Journal of Theoretical Politics*, 17(1): 107-136.
- [61] Micklewright, John. 2001. "Should the UK government measure poverty and social exclusion with a composite index?" Manuscript, UNICEF Innocenti Research Centre, Florence.
- [62] Miller, Alan J. 2002. *Subset Selection in Regression*. 2nd ed. Boca Raton: Chapman & Hall/CRC.
- [63] Nussbaum, Martha. 2000. *Women and Human Development: The Capabilities Approach*. Cambridge: Cambridge University Press.
- [64] O'Donoghue, Ted and Matthew Rabin. 2003. "Studying Optimal Paternalism, Illustrated by a Model of Sin Taxes." *The American Economic Review Papers & Proceedings*, 93(2): 186-191.
- [65] ONS. 2011. "Initial investigation into Subjective Well-being from the Opinions Survey." Office for National Statistics.
- [66] Page, Benjamin I. 1976. "The Theory of Political Ambiguity." *The American Political Science Review*, 70(3): 742-752.
- [67] Palfrey, Thomas R. 2006. "Laboratory Experiments." In *The Oxford Handbook of Political Economy*, ed. Barry R. Weingast and Donald A. Wittman, 915-936. Oxford, UK: Oxford University Press.
- [68] Palfrey, Thomas R. 2009. "Laboratory Experiments in Political Economy." *Annual Review of Political Science*, 12: 379-388.
- [69] Rabin, Matthew. 2013. "An Approach to Incorporating Psychology into Economics." *American Economic Review: Papers & Proceedings*, 103(3): 617-622.
- [70] Rawls, John. 1971. *A Theory of Justice*. Cambridge: Harvard University Press.
- [71] Rutström, E. Elisabet and Nathaniel T. Wilcox. 2009. "Stated Beliefs Versus Inferred Beliefs: A Methodological Inquiry and Experimental Test." *Games and Economic Behavior*, 67(2): 616-632.
- [72] Ryff, Carol D. 1989. "Happiness is Everything, or Is It? Explorations on the Meaning of Psychological Well-Being." *Journal of Personality and Social Psychology*, 57: 1069-1081.

- [73] Sen, Amartya. 1979a. "Utilitarianism and Welfarism." *Journal of Philosophy*, 76(9): 463-489.
- [74] Sen, Amartya. 1979b. "The Welfare Basis of Real Income Comparisons: A Survey." *Journal of Economic Literature*, 17(1): 145.
- [75] Sen, Amartya. 1985. *Commodities and Capabilities*. Oxford: Oxford University Press.
- [76] Sen, Amartya. 1992. *Inequality Reexamined*. New York: Russell Sage Foundation; Cambridge: Harvard University Press.
- [77] Stiglitz, Joseph E., Amartya Sen, and Jean-Paul Fitoussi. 2009. *Report by the Commission on the Measurement of Economic Performance and Social Progress*. www.stiglitz-sen-fitoussi.fr
- [78] Tomz, Michael and Robert P. Van Houweling. 2009. "The Electoral Implications of Candidate Ambiguity." *American Political Science Review*, 103(1): 83-98.
- [79] van Dijk, Eric and Marcel Zeelenberg. 2003. "The Discounting of Ambiguous Information in Economic Decision Making." *Journal of Behavioral Decision Making*, 16(5): 341-352.
- [80] Wittman, Donald. 1983. "Candidate Motivation: A Synthesis of Alternative Theories." *American Political Science Review*, 77(1): 142-157.